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Forest Service

**Equipment
Development
Center**

Missoula, MT

Vegetative Rehabilitation & Equipment Workshop

40th Annual Report
Orlando, Florida
February 9 & 10, 1986

**September 1986
2200—Range
8622 2816**

Vegetative Rehabilitation & Equipment Workshop

40th Annual Report
Orlando, Florida
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PARTICIPANTS

U.S. Department of Agriculture
U.S. Department of the Interior
State and County Organizations
State Wildlife Agencies
Industry Representatives (Chemical, Equipment, Mining, Seed)
Educational Institutions
Ranchers
Foreign Countries

September 1986

United States Department of Agriculture

Forest Service

WO

May 2, 1986

Dear VREW Participants:

The 1986 workshop, attended by approximately 110 people, was held in Orlando, Florida. The session was extremely informative about the phosphate mining industry in Florida and the industry's regulatory and reclamation processes.

A special thanks, from all who attended, goes to Joe Howell for serving as moderator of the morning session and for making those arrangements and contacts with local individuals who participated as speakers for the meeting.

Dr. Dave Robertson outlined Phosphate Reclamation Status - Past, Present, and Future; John Bunch discussed Mining Techniques and Soil Reclamation; Kevin Ruesch presented Revegetation and Land Use Planning and Jeremy Craft and Bud Cates gave an overview of the Laws, Regulations, and Policy on the effects of Phosphate mining activities. Your contribution to the meeting was appreciated.

Another interesting topic was information on the "Avery Automatic Stroke Device" for windmill efficiency. This recent technology breakthrough was presented in the structural range improvements work group by Robert Childress, District Ranger, Nebraska National Forest.

The VREW budget for development of new equipment will continue to be reduced for the foreseeable future. Our future efforts will be centered on making past and present technologies available to users on equipment and materials now available in range and disturbed land reclamation.

The 1987 VREW workshop will be held in Boise, Idaho, February 8-9, 1987. Hope to see you there.

Sincerely,

Gerald A. Henke

GERALD A. HENKE
Chairman, Vegetative Rehabilitation
and Equipment Workshop

Contents

Sunday – Feb. 9

Opening Remarks . . . . . Gerald A. Henke, *Chairman,* VREW

Panel Discussion: Phosphate Mining in Florida
Panel Moderator . . . . Joe W. Howell
Gurr & Associates, Lakeland, FL

Mining Techniques and Soil Reclamation . . . . John Bunch
Gurr & Associates, Lakeland, FL

Revegetation and Land Use Planning . . . . . . Kevin Ruesch
Gurr & Associates, Lakeland, FL

Reclamation Status -- Past, Present, and Future . . . . Dr. David J. Robertson
Florida Institute of Phosphate Research, Bartow, FL

Phosphate Mine Reclamation – Laws, Regulations and Policy . . . . Jeremy A. Craft
Florida Department of Natural Resources, Tallahassee, FL
James W. "Bud" Cates
Florida Department of Natural Resources, Bartow, FL

Use of Fire as a Tool to Manage Vegetation . . . Bill Leenhouts
U.S. Fish & Wildlife Service, Titusville, FL

Wetland Grazing Management and Improvement on the National Forests in Florida . . . . William C. Bodie
Forest Service, Tallahassee, FL

Roller Chopper . . . . George W. Tanner
University of Florida, Gainesville, FL

Workgroup Reports

Plant Materials . . . . Wendall R. Oaks
Soil Conservation Service, Los Lunas, NM

Interseeders . . . . Joe Frazer
Soil Conservation Service, Los Lunas, NM

Wildflowers . . . . Wayne G. McCully
Texas Transportation Institute, Vernon, TX

Seeding and Planting . . . . William J. McGinnies
Agricultural Research Service, Fort Collins, CO

New Seed Drill . . . . Robert A. Teegarden
Bureau of Land Management, Billings, MT

A Heavy Roller for Seedbed Preparation and Hayland Preconditioning . . . . Paul E. Nyren
North Dakota State University, Streeter, ND

Coated Seed as a Tool for Revegetation . . . . Stu Barclay
CelPril Industries, Inc., Hermiston, OR

Arid Land Seeding . . . . Harold T. Wiedemann
Texas Agricultural Experiment Station, Vernon, TX

Disk-Chain Performance . . . . Harold T. Wiedemann
Texas Agricultural Experiment Station, Vernon, TX

Establishment of Range Grasses on Various Seedbeds at Four Creosotebush Sites in Chihuahua, Mexico and Arizona, USA . . . . M.H. Martin, F.A. Ibarra
Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora
J.R. Cox, H.L. Morton
Agricultural Research Service, Tucson, AZ

The Use of Fire, Grazing Livestock, Insecticides, and Plant Germplasm to Control Spittlebug in Buffelgrass Pastures in Northern Mexico . . . . O. Cazares, M.H. Martin, F.A. Ibarra
Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora
J.A. Morales
Instituto Tecnologico y de Estudios Superiores de Monterrey, Nuevo Leon
H.L. Morton, J.R. Cox
Agricultural Research Service, Tucson, AZ

Chemical and Mechanical Brush Control and the Response of Native Grasses in the Chihuahuan and Sonoran Desert . . . . F.A. Ibarra, M.H. Martin
Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora
H.L. Morton, J.R. Cox
Agricultural Research Service, Tucson, AZ

Disk-Chain in Utah . . . . Robert Knudson
Forest Service, Missoula, MT

Monday – Feb. 10

Mechanical Plant Control . . . . Gus Juarez
Bureau of Land Management, Grand Junction, CO

Structural Range Improvements . . . . Billy H. Hardman
Forest Service, Missoula, MT

Avery Stroke Control Device for Windmills . . . . Robert G. Childress
Forest Service, Hot Springs, SD

Diagonal Fence Strainer Use and Other Fence Developments . . . . Dan W. McKenzie
Forest Service, San Dimas, CA

Range Structural Equipment Handbook . . Billy H. Hardman
Forest Service, Missoula, MT

Information and Publications . . . . Dick Hallman
Forest Service, Missoula, MT

Reclamation Status — Past, Present, and Future

Dr. David J. Robertson, *Florida Institute of Phosphate Research, Bartow, FL*

Introduction

Phosphate mining in the pebble district of central Florida began about 1880 and has had a history of almost continuous growth since then. Mining began with dredging operations in the Peace River, then moved on-shore to exploit the rich land pebble deposits. Land pebble was first mined hydraulically until the 1920's when electric draglines supplanted high-pressure water. Since the turn of the century, central Florida has assumed world leadership in the production of phosphate rock. Land disruption has paralleled the rate of mining and has become increasingly visible.

Legacy of Early Mining

Early mining operations used water to wash the pebble phosphate out of the sandy matrix. Once land preparation was completed, actual excavation of overburden began, first with mules and horses, and later with steam shovels. The exposed matrix was then slurried with high-pressure water, washed into a sump, and removed by centrifugal pumps to the washer plant.

The hydraulic pits were deep and steep-sided, but when they were abandoned and filled with water they created relatively circular lakes that harmonized well with central Florida's topography. Despite the fact that the basin morphology differed significantly from the typical bowl-shaped central Florida lakes, the pits were productive and earned a reputation for supporting large game fish populations.

The use of hig-pressure water to remove the phosphate matrix thoroughly mixed the sand and clay components of the matrix and threw them up in mounds surrounding the excavations. Since the spoils were composed largely of the sand and clay fractions as well as significant quantities of overburden, hydraulic spoils were in many respects very similar to native undisturbed soils. In addition, most of the hydraulic operations were small and did not disrupt vast contiguous acreages. Consequently, the spoil mounds rapidly revegetated from local seed sources and today support luxuriant growth typical of mesic hardwood hammocks. The woods are dominated by large, mature water oaks and live oaks and other hardwoods, with an open understory of palmettos and other shrubs. Because the habitat that has redeveloped on the spoil mounds surrounding the hydraulic pits is essentially identical to undisturbed hammock habitat, these areas support virtually all of the aquatic and terrestrial wildlife normally associated with hardwood for forests and lakes.

The sites of early hydraulic mining operations are now eagerly sought as lakefront homesites. The lakes are surrounded by rolling hills clothed by a canopy of mature oaks that enhance the beauty of the areas and are practically indistinguishable from natural lakes. Hydraulically mined areas have been extensively developed for exclusive residential areas south of Lakeland.

In addition to the drier uplands, mining disrupted portions of the Peace and Alafia River basins in the central Florida phosphate district and in the Suwannee River Basin in northern Florida. Numerous tributary streams in these river basins were subjected to mining-related alterations. The changes ranged from relatively minor modifications brought about by drainage rerouting to complete restructuring by mining processes. In addition to directly altering stream channels through diversion, the Florida phosphate industry also exerted more subtle effects on streams. Alterations in hydrology produced by mining, draining of wetlands, and changes in stream and groundwater chemistry all had impacts on riparian forest ecosystems.

Environmental awareness was low during the first half of this century; wetlands were considered (with some justification) as mosquito-infested wilderness areas that would be best drained and used for productive purposes. There was no incentive to encourage their redevelopment. The only wetlands that were created were done so unintentionally. The steep sides of the lakes did not encourage the redevelopment of littoral wetlands and the removal of vegetation from floodplains left no seed source for revegetation of hardwood swamp. Consequently the forested wetlands that persist from this period of mining are depauperate, both in terms of dominant trees and undergrowth.

Development of the Modern Mining Industry

Beginning in the second decade of this century, mineral processing by the phosphate industry began to undergo a revolution that led to significant changes in reclamation. The first major change occurred when hydraulic mining was supplanted by increasingly larger electric draglines. Although the method of obtaining the ore changed significantly with the introduction of larger excavators, however, phosphate operations were still limited to removing only the pebble-sized particles as a product and discarding the clay, sand, and sand-sized phosphate.

With the advent of shovels and electric draglines during the 1920's, phosphate began to be mined in parallel excavations often 200 to 300 feet wide and 2,000 feet long. Overburden was simply cast into an adjacent cut in the most convenient manner, usually in high windrows. The pits were often 60 feet deep and spoil windrows were narrow, steep, and unstable. The configuration of water-filled pits separated by intervening spoil windrows is often referred to as a "finger lake." Where the mining cuts were sufficiently wide, many of the spoil piles were flattened and the areas reclaimed as "land and lakes." These areas have become popular lakefront homesites, although the narrow, linear nature of the windrowed spoil severely restricts the size of the lots. Numerous subdivisions south and east of the city of Lakeland and south of Bartow have been developed along the edges of the finger lakes.

A few lakes created by dragline mining were nearly indistinguishable from natural lakes in the region. These lakes were a result of deliberate plans to create large, open pool rather than long, narrow interconnected canals. American Cyanamid began creating these lakes in 1960. Instead of mining in standard parallel cuts, Cyanamid pivoted smaller cuts around a centralized axis that became the future lake. The overburden was distributed in previously mined cuts to approximately ground level. It was then a relatively simple and inexpensive matter for bulldozers to grade the overburden to achieve the final elevations.

The second major innovation that helped shape the modern phosphate industry was the introduction of hydrocyclones, which allowed the clay-sized particles (the "slimes") to be separated from the sand-sized particles. The clay comprises one-third of the weight of the matrix, along with phosphate and sand. However, the removal of the clay diminished the quality of the soil for reclamation because the water- and nutrient-holding portion of the matrix had been segregated from the silica sand tailings.

Once they were separated from the rest of the matrix, the clays were at first allowed to fill the open mine cuts. When it came to be recognized that the clays were difficult to manage in the mining cuts, they were then routinely impounded behind above-grade sand-tailings dams.

The third and final major development in the phosphate industry occurred in the 1940's with the universal adoption of flotation. Flotation allowed for the recovery of the sand-sized fine fraction of the phosphate matrix that had formerly been discarded. With the implementation of flotation, the sand tailings were used to fill the mine cuts.

The result of these three developments was a vast disturbed landscape of phosphatic clay settling areas, mining excavations filled with water between steep, narrow spoil windrows, and other excavations filled with sterile sand-tailings.

Phosphatic Clay Settling Areas. Since 1971, the clays have been settled behind large, well-engineered dams constructed of overburden excavated from mined-out areas. Approximately 100,000 acres have been devoted to active and inactive clay settling ponds.

Natural reclamation on phosphatic clays proceeds through well-established stages, although succession may be interrupted depending on localized site-specific conditions. Generally, the settled phosphatic clays are initially invaded by cattails, which form a monoculture that persists until standing water evaporates or is drawn-off. The cattails are then slowly replaced by impenetrable thickets of primrose willow and coastal plain willow. If the site continues to dry, the willow thickets are replaced by mixed associations of willow, wax myrtle, and saltbush. Hardwoods are very rare, although there are indications that the major problem with hardwood establishment may be one of seed source availability rather than the ability of trees to survive in the clays.

The majority of clay settling areas filled before 1975 support this willow-wax myrtle-saltbush vegetational community. Settling areas in early stages of succession with large expanses of open water provide valuable habitat for wetland and aquatic wildlife. However, once the sites dry and are invaded by willows and myrtle, the value of settling areas for wildlife is sharply reduced. Because of the unstable nature of consolidated clay soils, the generally uneven topography of the settling areas, and the unattractive shrubby appearance of the natural vegetation with little to offer to wildlife, most of the clay settling areas would benefit from reclamation.

Sand Tailings. As a result of their loose texture and high porosity, sand tailings are extremely droughty. Their inability to retain moisture severely restricts revegetation, and as a consequence, tailings areas are characterized by low diversity and biomass. Vigorous old field succession initiates the process of vegetating these areas. Herbaceous growth begins soon after mining is completed as ragweed, dog fennel, and natal grass begin to colonize the bare soil. Only a few shrubs are present (e.g., saltbush) and trees are absent.

Wildlife use tends to be poor. As might be expected, few reptiles and no amphibians are found on tailings areas because the very open, sunny aspect creates severe conditions that most species find intolerable. In addition, no burrows are available to provide protection from the sun. Tailings-fill areas are only slightly more hospitable for small mammals; these areas generally support low to intermediate levels of rats, mice, and shrews. The avian fauna is also characterized by fairly low diversity and abundance, but the open grasslands provide habitat for some species that do not inhabit other types of reclaimed landforms. The presence of tailings areas serves to increase avian diversity in a regional, if not localized, context. Tailings areas also appear to be ideal for some types of insects. Ungrazed tailings areas have the most abundant

insect fauna of all upland habitat types measured. Strangely though, the tailings areas are dominated by small beetles and by caddisflies, the larvae of which are exclusively aquatic organisms.

Because of the very poor agriculture qualities of sand tailings, the quartz sand refuse from the beneficiation of the phosphate matrix is no longer left exposed on the surface of reclaimed land except where the droughty nature of the material is an asset, as in xeric ecosystem reclamation. More commonly, tailings are used to fill the mining cuts, then are capped with a layer of overburden to improve soil fertility, structure, and moisture retention. Although the overburden cap will sustain plants with relatively shallow roots such as pasture grasses, trees that develop deep and extensive root systems may suffer if the surficial aquifer recedes, leaving the trees rooted in dry sand. In addition, while the level of sand tailings in a mining cut may be adjusted to a certain extent to regulate post-reclamation drainage and water-table characteristics, the water table following mining may not closely match that of undisturbed land.

Contemporary Reclamation and Prospects for the Future

Cattle Production. Pasture grasses generally show satisfactory establishment on land reclaimed with overburden or an overburden cap. Consequently, very little research has been directed toward improving range quality. The two studies that *have* been conducted were performed on sand tailings areas rather than on overburden. In general, results indicated that amending the tailings with phosphatic clay and sewage sludge or topsoil produced better yields of grasses, although yield increases of the perennial species disappeared after the second year. Forage legumes were beset with problems, but generally showed little response to the soil amendments. Nonetheless, the results indicated that relatively low forage yields of good quality and adequate nutritional content for beef cattle can be produced on tailings.

There is increasing interest in reestablishing native rangeland instead of improved pasture on reclaimed land. Encouraging revegetation with native grass and legume species may: (1) reduce competition of exotic turf grasses with planted trees, (2) provide better wildlife habitat, and (3) lower reclamation and maintenance costs.

Row Crops. Row cropping is a relcamation option that has been used only infrequently in the past. Sand tailings soils are too infertile and droughty for efficient production of row crops. The poor tillage characteristics of overburden and phosphatic clay have discouraged extensive use of these soils for row crop production. However, there have been a few attempts to produce row crops on reclaimed land. Occidental Chemical Co. in north Florida has leased extensive holdings to local farmers for the production of row crops on overburden. Most other agriculture has been conducted on phosphatic clays. The clays are naturally fertile because of their high colloidal phosphate content and high cation exchange capacity. In addition, even desiccated clays have excellent water-holding abilities, giving them a distinct advantage over Florida's typically well-drained sands. Regardless of these benefits, though, settling areas have not been extensively devoted to agriculture because of poor tillage characteristics, drainage difficulties, a heavy, compact soil structure, surface instability, a lack of knowledge regarding potentially suitable crops, and a general inexperience with this nonnative soil by local agricultural personnel. The Florida Institute of Phosphate Research is currently supporting a 10-year program to overcome these difficulties and bring settling areas into agricultural production.

Citrus. Despite the fact that surface mining for phosphate ore is geographically coincident with the State's most productive citrus-growing area, few reclaimed areas have been devoted to citrus groves. Citrus requires a well-drained, but not particularly fertile soil. It also requires a site that is free from prolonged sub-freezing temperatures. Traditionally, the best citrus land in central Florida has been the sand hills of the Lake Wales and Winter Haven Ridges, preferably in areas bordered on the north by a lake for cold protection. Nearly all the best citrus land has either already been planted in citrus or developed for other purposes. Moreover, in recent years a considerable acreage of prime citrus land has been lost to urban development. There is a strong demand for land suitable for citrus in central Florida today.

Citrus groves have been established at eight locations on reclaimed land in Polk and Hillsborough counties. Five of the groves were established since 1980 and appear to be progressing well. Two other groves have been producing fruit for many years. An eighth grove between Bartow and Winter Haven was abandoned as a failure, although the underlying reasons for the lack of success are unknown. Since citrus grows best in well-drained soils with minimal quantities of clay, slightly amended sand tailings may be ideal sites for future groves.

The potential for growing citrus on reclaimed land needs to be evaluated in a comprehensive study. Analogs of natural citrus land may already exist on reclaimed areas. For example, above-grade clay settling areas that have been capped with sand tailings bear some resemblance to the natural sand hills of the Ridges. Such areas, especially those bordered by reclaimed lakes, may make excellent citrus sites. Other areas reclaimed with sand tailings or overburden may be potential candidates for grove land.

Silviculture. Silviculture is another potential agricultural use of reclaimed land. However, central Florida is not a traditional timber producing area. The nearest pulp mills are in north Florida and because of the transportation costs, timber prices in central Florida are typically much lower than in north Florida. In addition, pine plantings on natural ground in central Florida generally do not do as well as those further north. Nevertheless, a few pine plantations do exist on reclaimed land, especially at Occidental Chemical's Suwannee River Mine in north Florida. Measurements indicate better performance on reclaimed land than on native soils, probably due to lack of a hardpan, less competition, and higher levels of phosphate. Eucalyptus plantations for pulpwood have also been proposed on a limited basis, but there are no facilities to process the raw materials.

Lakes. The current rules of the Department of Natural Resources dealing with mine reclamation contain precise guidelines for the reclamation of water bodies created by mining after 1975. Unlike hydraulic pits, slopes at the bottom of lakes within 25 feet of the shoreline must not be steeper than 4:1 horizontal to vertical as measured from the lowest anticipiated water line. In order to encourage the development of littoral vegetation, at least 25 percent of the lake surface must be within a zone of water fluctuation, or alternately, wetlands must be created adjoining the lake. In addition, at least 20 percent of the surface must fall within a zone between the annual low water line and the -6 feet annual low water line and the -6 feet annual low water to provide for bedding areas and submerged vegetation zones.

The rules for lake reclamation were promulgated to encourage the development of lakes more like natural Florida lakes with shallow, dish-shaped basins, a well-developed littoral area, and a large portion of the water column within the euphotic zone. Despite the fact that deep, steep-sided lakes have considerable merit for some forms of recreation and water quality improvement, little research has been carried out to weigh the costs and benefits of reclaiming pit lakes to a condition more closely matching the typical natural basin lake. Result of preliminary investigations indicate considerable variability between lakes, both natural and reclaimed, especially in the fisheries. The physical and chemical characteristics show more stability and greater similarities but there are distinct differences between the lakes nonetheless. As more limnological data are developed, it may become possible to tailor reclamation activities for specific intended lake uses.

Wetlands. The ability of settling areas to support wetland vegetation is undisputed. Unfortunately, the wetlands that have become established in clay settling areas are generally less than desirable because of very low plant diversity and the dominance of aggressive, early successional weedy speices. However, evidence is gradually accumulating to indicate that, with the proper species introductions and site management, well-drained or seasonally inundated settling areas can support hydric and mesic arboreal vegetation. Additional research into the feasibility of establishing wooded wetlands on settling areas that are hydrologically similar to natural sites needs to be explored as an option for replacing wetlands that are subject to mining. The possibilities for encouraging the establishment of freshwater marshes on settling areas also need to be investigated, but intensive management might be required for long periods until a hydrologic regime can be established that will encourage growth of desirable species and prevent the rank growth of cattails and persistent woody shrubs.

Although the clay settling areas may not be readily amenable for developing herbaceous wetlands and marshes, considerable progress has been made on the reclamation of these systems on overburden and sand tailings capped with overburden. Mulching with borrowed wetland topsoil has become a standard technique that generally yields good to excellent results. However, additional work is needed that could improve the rate of success of wetland establishment. Research is needed to determine the lifetime of stockpiled organic soils and the rate at which propagule viability decreases, how the source of the mulch effects the final species composition in the reclaimed area, why mulching is successful (whether because it serves as a "seed bank," a source of microbial inocula, retains water and nutrients, or some other reason), the most economical technique for introducing desirable species of vegetation, and improved techniques for controlling weedy invaders until desirable vegetation has become firmly established.

Unlike marsh reclamation, where considerable success has been demonstrated, hardwood swamp rehabilitation is in its infancy. Individual swamp reclamation attempts have been limited in number and have been relatively site specific. Three aspects of swamp reclamation have hampered progress. the first is that the vegetation that defines a swamp—hydric trees—grows slowly in comparison with herbaceous march vegetation. The slow growth allows weedy invaders to colonize the site and detract from the generally preceived visual concept of a swamp. Methods for more economically introducing canopy trees and associated understory vegetation, (e.g., straw or plastic mulch, selective sodding with annual or perennial grasses, temporary "nurse" vegetation, hydroperiod control) would certainly contribute to the success of swamp revegetation.

Stream reclamation is also becoming increasingly important. Stream relocation to allow mining and the subsequent rehabilitation of the system in terms of water quality, aquatic biota, and riparian habitat are particularly controversial because virtually no data have been collected to demonstrate or refute that a stream and its environs can be reclaimed. Stream reclamation is a multifaceted problem involving channel relocation and topographic alignment, water quality maintenance, and downstream monitoring to document perturbations. Stream reclamation research involves considerable data collection and monitoring both before and after relocation.

Although surface mining for phosphate ore has long despoiled central Florida's landscape, reclamation provides opportunities to create land for attractive lakefront residental development, sites for recreation and parks, natural areas providing wildlife habitat, and soils that may be more suitable for agriculture and grazing than were available before mining.

Phosphate Mine Reclamation — Laws, Regulations, and Policy

Jeremy A. Craft and James W. "Bud" Cates, *Florida Department of Natural Resources, Tallahassee, FL*

The phosphate industry is regulated by a variety of State, regional and local agencies in Florida. The Department of Natural Resources Bureau of Mine Reclamation is responsible for the review and regulation of all reclamation activities. The Department of Environmental Regulation regulates mining and, for mitigation purposes, the reclamation and restoration of wetland areas. The regional water management districts are beginning to implement regulation for the management and control of surface waters. They already regulate the consumptive use of groundwater. The regional planning councils, in conjunction with the local governments, review new mines and large expansions of existing mines through the development of regional impact programs. The local governments also require annual mining and reclamation approvals.

The Bureau of Mine Reclamation is divided into three sections. The mandatory section is responsible for the review of reclamation programs on those lands mined after July 1, 1975. Lands mined since that date are subject to a mandatory requirement for reclamation.

The nonmandatory section administers an incentive grants program for the reclamation of those lands mined prior to July 1, 1975. This program allocates a portion of the nonmandatory land reclamation trust fund each year to provide grants to reimburse landowners for the reclamation of these lands. The trust fund, which is administered by the Bureau, receives 10 percent of the revenue received through a phosphate severance tax imposed by the State legislature in 1971. At present, the nonmandatory program provides grants of approximately $6 million per year for reclamation purposes. Beginning in July 1986, an acquisition program will commence to allow the purchase of lands mined prior to July 1, 1975, for use as recreational areas, wildlife areas, or other public purposes. We envision this program providing the money necessary to acquire land to expand existing State and local government parks and to provide recreational and wildlife corridors between parks as well as providing a mechanism for the planned reclamation of drainage systems such as streams and their associated hardwood wetland and wildlife systems.

The technical support section was recently created to study problems within the mining industry, such as clay consolidation, surface water and groundwater hydrology, and to provide support to the other two sections in the evaluation and analysis of reclamation programs.

Now let us discuss specifics of the standards and criteria by which we evaluate the reclamation under the two programs, nonmandatory and mandatory. The two sets of criteria are similar and yet divergent. First, let us address some of the differences. The intent of the nonmandatory program is to identify and provide guidelines for the donation or purchase of those lands mined prior to July 1,1975, and to provide grants for the reclamation or purchase of these lands.

Application is made annually to the Bureau of Mine Reclamation by landowners seeking to have their reclamation projects or programs funded. Bureau personnel prioritize these applications based on criteria established in the law. These include the protection of general health and safety, the establishment of agricultural lands, and the equitable distrubution of funds between both landowners and counties. Bureau staff recommends the priority list to an advisory committee, which is appointed by the Governor. The committee then makes recommendations for funding to the Governor and Cabinet. Once funding has been approved and contracts have been signed, Bureau personnel periodically inspect the programs to ensure that performance standards and criteria are met.

One of the subtle differences between the two programs is that the nonmandatory program can, to a limited extent, direct land form and land use through the prioritization process. The mandatory rules address land use in much more limited and defined terms. Under the mandatory rules landowners must submit annual or biennial applications for lands to be mined within the coming year and include in these applications reclamation plans for each mining parcel. Each mine must also have a conceptual mine plan on file with the Bureau prior to mining. This plan delineates mining areas, waste disposal areas, and intended reclamation, including future land use and landform, revegetation patterns, and watershed restoration. The staff can only direct land use to the extent that wetlands must be reclaimed on an acre-for-acre and type-for-type basis; the upland acreage of each reclamation parcel must be at least 10 percent forested; and regional watersheds and drainages must be restored to a functional equivalent of the premining state. The performance standards and criteria are essentially the same. Main areas of interest are:

Safety:

Site cleanup - removal of all mine equipment and refuse is required.

Structures - removal of temporary buildings, pipelines, powerlines, and roads is required.

Grading, Contouring, and Backfilling:

Natural appearance of the land must be returned in a manner compatible with the intended land use.

Slopes may be no steeper than 4 feet horizontal to 1 foot vertical.

Wetlands and Waterbodies:

Subaqueous slopes must be no steeper than 4:1 out to a depth of at least 6 feet.

The design should be consistent with health and safety considerations, maximize beneficial contributions with local drainage patterns, provide aquatic and wetland wildlife habitat, and maintain downstream water quality by preventing erosion and providing nutrient uptake.

Waterbodies must incorporate a variety of emergent habitats and a balance of deep and shallow water zones.

Drainage and Flooding:

Drainage patterns must be restored.

Reclamation contouring and grading must eliminate the risk of off-site flooding.

Water Quality:

All waters of the State on or leaving the landowner's property must meet Florida Department of Environmental Regulation water quality standards.

Water within all waterbodies must be of sufficient quality to support fish and wildlife.

Revegetation:

Wooded uplands and wetlands must have a surviving density of 200 trees per acre at the end of a 1 year growing season.

All species must be indigenous to the State with the exception of grasses, temporary ground cover, and agricultural crops.

Forested areas must be protected from grazing, mowing, fire, and other adverse land uses.

At least 80 percent of the land area must have established groundcover after one growing season. Bare areas cannot exceed one quarter of an acre.

Through the studies of the technical support section and the Florida Institute of Phosphate Research, we expect to improve our ability to comply with the above criteria and to improve our ability to reclaim and restore beneficial ecosystems on mined lands. Florida receives an excess of 60 inches of rainfall per year. Studies in the near future will be directed at the reestablishment of the surficial aquifers and at understanding the hydrology of these nonartesian systems. Studies also will be directed at the management and re-creation of streams and other surface waters. We visualize the reclamation of surface landform and drainage systems to be based on computer models so that drainage and discharge hydrographs of reclaimed landforms may be similar to those that existed prior to mining.

Wooded wetlands cover much of the known reserves within the State of Florida. The restoration of these valuable systems is necessary for the environmental well-being of the State. Continued research into the reestablishment of these systems will continue. The restoration of all wildlife habitats is vital in a State being subjected to the growth pressures that we see in Florida. Our State is growing by approximately 1,000 new residents per day. Habitat destruction is occurring at a rate that has never before been exceeded in our State's history.

The reclamation of habitat, both wetland and upland, is vital on mined land. We visualize continued research in the restoration of wetland habitat. Likewise, we visualize new research in the establishment of unique upland systems such as sandpine scrub. The time between mining and reclamation is another area of continuing research. There is a general perception that it takes 10 to 15 years to reclaim clay settling areas. Experimental programs have indicated that reclamation of these areas can be accomplished within 3 years. We anticipate being able to speed reclamation of all mined lands to within a 3 year period. Finally, we envision extensive studies dealing with local government and land use so that we may plan the future reclamation of mined lands to be in concert with the growth demands of Florida.

Use of Fire as a Tool to Manage Vegetation

Bill Leenhouts, *U.S. Fish & Wildlife Service, Titusville, FL*

The Merritt Island and St. Johns National Wildlife Refuge has been expanding its prescribed fire operations since the 1970's. Since that time prescribed fire has expanded into a complex program involving over 50,000 acres and encompasses many vegetation types, some of which are fire adapted and some that are not. The objective of this presentation is to illustrate the response that different vegetation types have to fire and how this knowledge is used in management decisions.

The history of prescribed fire dates back to the 1970's when experimental fires were attempted in the salt marshes of Merritt Island. The first operational program began in 1978 with a systematic program of ground ignited prescribed fire on the St. Johns to enhance dusky seaside sparrow habitat. At about the same time some limited ground ignited prescribed fires were being conducted in the upland communities of Merritt Island. Following the disastrous 1981 wildfire season, it was determined that a fuel reduction prescribed fire program was needed over approximately 50,000 acres of Merritt Island to offset 25 years of total wildfire suppression policy.

Since the Merritt Island National Wildlife Refuge occupies all the nonoperational lands of the Kennedy Space Center, with the many constraints the Center imposes, the classic 100- to 200-acre ground ignited prescribed fires were impractical. Aerial ignition of large blocks was the only practical solution to achieve the yearly acreage targets of approximately 18,000 acres. The 50,000 acres represents 70 percent of the terrestrial area of the refuge and includes almost every vegetation type. Within any large block that averages 2,000 acres, there are several vegetation types each responding differently to fire. This has provided a means of determining how each vegetation type will react to fire under the same burning conditions.

Historic wildfires were summer lightning fires started from the 10,000 to 30,000 cloud-to-ground lightning strikes that occur during the summer thunderstorm season. Both winter and summer prescribed fires have been used for the initial fuel reduction. The ultimate objective is to utilize summer prescribed fire to simulate the natural fires.

The vegetation types of Merritt Island and St. Johns National Wildlife Refuge can be subdivided into those which have frequent fire intervals: flatwoods, grass marsh, palm savannah; have infrequent fire intervals: scrub, coastal strand, coastal dune; are nonfire types: hammocks, swamp, ruderal. The following are description, summaries of the fire response, and management options for each of the vegetation types.

Helitorch aerial ignition firing in action at the Merritt Island National Wildlife Refuge.

Frequent Fire Interval Vegetation Types

These vegetation types build fuel loads capable of supporting fire within 2 to 3 years following the last fire and are easily ignited under average climatic conditions.

Flatwoods: Flatwoods are usually dominated by a tree layer of slash pine and thus called pine flatwoods. The shrub layer is dominated by saw palmetto with many other woody species present: fetterbush, gallberry, wax myrtle, and scrub oak species. A well-developed herb layer is present. However, in areas such as the central portion of Merritt Island, the tree layer may be absent but the shrub and herb layer is identical to the pine flatwoods and is called a pineless flatwoods. The vegetation in all three layers is well adapted to frequent fire.

Under average conditions the pineless flatwoods vegetation will support fire 3 years after the last fire, but only about 50 percent of the total vegetation will burn. The burn will exhibit a mosaic determined by microclimates and natural fire breaks within the vegetation. Seventy percent of the vegetation will burn in 4-year-old fuels, and as the fuels get older a higher percentage of the vegetation will burn in any given fire. The pine flatwoods with a uniform overstory of more than 60 percent crown coverage will support fire 2 years after the last fire and be fairly uniform with approximately 70 percent burned. During a drought the burning frequency decreases by 1 year for both the pine and pineless flatwoods vegetation types. Fire in the pine flatwoods during droughts with vegetation ages greater than 6 years has resulted in significant loss of the slash pine overstory.

A prescribed fire frequency of 3 years meets most of the refuges fire and wildlife management objectives without significant loss of the slash pine overstory. Since only 50 to 70 percent of the available vegetation is burned at each 3-year interval, 30 to 50 percent of the vegetation will be 6 years old or older at the next prescribed fire. This mosaic of burning provides adequate fuels reduction and significant habitat edge and diversity.

Typical spot firing pattern.

Grass Marsh: Grass marshes are extensive areas of grass and herbs that occur in soils saturated and/or flooded with water. Smooth cordgrass is the major constituent of this vegetation type. Mangroves invade the fringe of the marsh, and woody vegetation such as groundsel tree and wax myrtle invade dryer sites where fire is excluded. Frequent fire intervals in the grass marsh can prevent the invasion of woody species. Winthin 10 years, woody species can become so dominant that there will be insufficient grass fuels to support fire.

Prescribed fire in the grass marsh has been used to maintain the grass wetlands and prevent the invasion of woody species. The grass marsh can support fire within 2 years following the last fire. Seventy percent of the vegetation will burn after 2 years and 90 percent after 3, again in a mosaic pattern. Woody species invasion can be maintained with fire frequencies of from 2 to 3 years. This includes the exotic Brazilian pepper. Woody species can be killed if burned when the roots are flooded by water. If the roots are not flooded basal sprouting will occur. Since the smooth cordgrass responds faster than the woody species following fire, it remains the dominant vegetation for up to 3 years, but after 3 years woody species begin to dominate. Prescribed fire at intervals of 2 to 3 years whether flooded or not can maintain the grass marsh.

Palm Savannah: The palm savannah is a grass marsh with an overstory of cabbage palms with less than 60 percent crown coverage. The cabbage palm is very fire tolerant as an adult, but may be vulnerable to fire as a seedling. In terms of fire, the palm savannah functions similarly to the grass marsh.

Infrequent Fire Interval Vegetation Types

Fire is a key component in these vegetation types. The fuels in these types are primarily live fuels and only capable of supporting fire when the live fuel moisture is depressed by dormancy of drought and the fuels are older than 3 to 5 years. Natural fire frequency in these types is from 10 to 30 years probably because the occurrence of drought, fuels old enough to support fire, and an ignition source only occur at these infrequent intervals.

Scrub: The scrub is an impenetrable thicket of woody plants usually dominated by myrtle oak with lesser woody species of sand live oak, Chappman's oak, fetterbush, and saw palmetto. It appears as one layer varying in height from 1 to 3 meters. Little herb layer vegetation is present. At times a tree canopy of sand pine is present.

The scrub only supports fire during times of dormancy or drought. During prescribed fire operations in blocks containing both flatwoods and scrub under normal summer conditions, the flatwoods support fire but the scrub would not support fire even though the fuels were older than 10 years. Only small openings are created by the aerial ignition operations amounting to less than 10 percent. Under normal winter conditions (dormancy), the scrub will support a headfire but not a backing fire. Winter fires usually burn strips varying in width, depending on ignition spacing. During drought when live fuel moistures are severely depressed, both head and backing fires occur.

The sand pine is a "disaster" species in that it requires fire to reproduce. The sand pine has a serotinous cone that requires heat to release the seeds and a seedbed that lacks competition from other vegetation to germinate and survive. A fire creates both conditions but also kills the adult sand pine. Because of this, natural sand pine forms an even aged stand as old as the last fire.

Summer prescribed fire in the coastal scrub community is used to create small openings and edge. It is hoped that this will be beneficial to the Florida scrub jay. Winter prescribed fire has been used to reduce fuel levels.

Coastal Dune and Coastal Strand: The coastal dune is a single layer of grass, herbs, and dwarf shrubs and is confined to the front of the primary dunes. It exists completely within the salt spray zone, and sea oats is the most obvious species present.

The coastal strand is a dense thicket of woody plants within close proximity to the Atlantic Ocean usually dominated by saw palmetto. Its profile is a single layer from 1 to 4 meters in height. The shrubs on the eastern margin usually are hedged by the salt spray.

The coastal strand and dune can support fire but seldom burn because of the high humidities created by the ocean. Both man and lightning caused wildfire has been documented in both types. There are no prescribed fire operations in the coastal strand or coastal dune vegetation types.

Nonfire Types

Nonfire vegetation types seldom support fire and have evolved in the absence of fire.

Hammocks: Hammocks are forests primarily dominated by broad-leafed evergreen trees. A well-developed tree layer, usually consisting mostly of live oak and cabbage palm, is always present. A shrub layer varying in height from 0.5 to 3 meters is present. And a herb layer may or may not be well developed; however, some herbaceous plants are always present.

Hammocks evolved in the absence of fire. Old fire scars are present in a number of hammocks on the refuge but prescribed fire has never been sustained within a hammock.

Swamps: Swamps are woody covered wetland areas adjacent to marshes and are characterized by woody shrubs and trees. The mangroves are included within this vegetation type.

Swamps usually lack any herb or shrub layer that can support fire. Prescribed fire has never been sustained within a swamp.

Ruderal: Ruderal are disturbed areas of natural vegetation types. Some areas are maintained by man and are predominantly composed of cultivated grasses, herbs, shrubs and trees. Other ruderal areas are areas that have been abandoned and have been allowed to naturally succeed. These abandoned areas succeed to many different ruderal types, depending on soils, moisture, and seed availability. Prescribed fire has been experimented with to control two exotic species that frequently invade abandoned ruderal areas.

Australian pine was planted around homes and citrus groves. Australian pines grow in monocultures with very little ground fuels. They are fire intolerant and can be killed by frequent and repeated fires. Prescribed fire has been used to control Australian pine with limited success. Prescribed fire must be used during droughts in order to get as complete and as hot a fire as possible with little ground fuels. These are also high fire danger conditions, and prescribed fire is avoided under these conditions.

Brazilian pepper is an exotic ornamental shrub that has invaded the dikes surrounding the mosquito control impoundments of the refuge. To maintain the dikes, the pepper must be removed. A commercial weed burner was used to heat and burn all the vegetation along the dikes under prescription. The heat was effective in killing above ground vegetation of pepper, but not cost effective. Herbicides have been found to be more cost effective in controlling pepper on the dikes. A standard drip torch is used to ignite combustible vegetation along the dikes in the winter. This has been found effective in removing excess biomass accumulation on the dikes and in doing so limited pepper control is achieved.

Wetland Grazing Management and Improvement on the National Forests in Florida

William C. Bodie, *Forest Service, Tallahassee, FL*

It is with a great deal of pleasure that I come before you today to share this overview of the wetlands situation on the National Forests in Florida, particularly as it applies to our program of range management.

Let me first describe for you, in general terms, the biological environment of the National Forests in Florida, which consists of three forests, all in the northern half of the State.

The pine flatwoods community predominates over the northern half of Florida, and longleaf/slash pine/wiregrass is the dominant vegetation type. Important grasses are pineland threeawn, creeping bluestem, chalky bluestem, lopside indiangrass, hairy panicum, broomsedge bluestem, perennial goobergrass, and numerous paspalum and panicum grasses. All these occur on both open rangeland and under the longleaf-slash pine overstory. Common understory plants include saw-palmetto, gallberry, southern wax myrtle, and fetterbush. Fertility is very low, with phosphorus being the most deficient element.

The early history of continuous heavy grazing, burning, and the selective grazing preference of cattle has favored the growth of unpalatable and fire-tolerant species such as pineland threeawn (commonly called wiregrass) and saw-palmetto over the more desirable creeping bluestem, indiangrass, and legumes. The lack of frequent, hot, growing-season fires since the implementation of our modern fire suppression program has also caused significant vegetative changes generally unfavorable to forage production.

In setting the stage for a discussion of resource management on wetlands, we also need to understand several other facts about Florida in general. Florida is among the fastest growing States in the nation. Between 1970 and 1980, the State's population increased by more than 43 percent. During the 1980's Florida will grow at a rate twice that of other sunbelt States and more than three times the rate of the United States, making it by 1990 the fourth most populous State. With more and more prime land that has previously been managed for production of various natural resources being displaced by human settlement, and with greater demands for the products previously provided by these lands, a whole new set of management "opportunities" has arisen.

One such "opportunity," or "dilemma," is the increased government regulation that has paralleled this phenomenal growth. Since our interest here today is in wetlands, and more precisely grazing in wetlands, I'll confine my discussion to the regulation of land management on wetlands, or on lands affecting wetlands. We must realize at this point that there are some slight differences in the degree of regulation on Federal versus private lands, and that I speak from an experience gained managing Federal land. Rather than distinguish between the levels of regulation, let's agree on a general statement that Federal lands, and Federally-assisted programs, are subject to all governmental regulations, from all levels of government, that concern water quality, and private lands are subject to slightly less regulation.

Regulation affects range management in many ways at various times and on various ownerships, but there are two primary ways. First, Florida's flat terrain and abundant rainfall combine with other factors to create a large area of wetlands interspersed with slightly higher ridges. Even on many of the ridges, particularly flatwoods, the perched water table is often above ground for varying periods of time. Any type of surface management activity is often benefited by surface water management, commonly in the form of simple drainage. Most dredge and fill activities are extensively regulated by the State of Florida.

A second regulatory effect that will be greater in the future is the special classification of certain waters of the State. An example is the classification called "Outstanding Florida Water." Regulations require that there be no degradation in water quality from the ambient standard at time of classification, except for temporary changes of less than 30 days. This has implications on many land management practices commonly used in the State. Examples are prescribed burning and fertilization. You can readily see where location of such things as feed lots, holding pens, etc., would fit in. Permits for regulated management activites in the vicinity of OFW's are given only when the activity is clearly in the public interest. Work such as that being done by George Tanner, that will provide water quality parameters of grazed versus ungrazed sand ponds at Avon Park Air Force Range, is invaluable to managers who are faced with permit applications, adverse public opinion, or uncertainty in making management decisions.

On Federal lands, there is a third major effect imposed by Executive Order 11990 on Federal projects planned on wetlands. This restricts the effects that Federal activities may have on wetlands and requires "early public review" of any planned activities in wetlands. With the rate of population growth I've described to you, the majority of expressed public opinion in Florida these days is to leave public land essentially in a natural state, especially wetlands. This is an especially perplexing management opportunity, or dilemma.

You can readily understand, I'm sure, from this brief overview that the definition of wetland is crucial. Each regulator, unfortunately, has its own, according to its vested interest. Some proposed vegetative indicator efforts would have extended wetlands in Florida virtually from sea to shining sea. We, of the National Forests in Florida, believe the best general definition is in EO 11990. It is, "Those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction." Keying on this, we add several specifics in order to translate the definition to management situations:

1. The soil will be in the waterlogged or very poorly drained class.

2. The vegetation will consist of a prevalence of water tolerant plants or hydrophytes.

3. There is normally standing water, or evidence thereof, for 6 months or more in most years.

You probably suspect by now that with all the regulations, difficulties and management dilemmas that are associated with wetland management in Florida, the National Forests are not doing much in the way of wetland grazing management. Well, you're right, so I'll sit down right now. Not really. By our own clinical definition of wetland, we are doing little on what we call wetlands, but we are doing quite a bit on lands that are wet. Allow me to make that differentation, if you will, and at the same time I'll admit that there are those who believe that our wetland definition does not encompass all wetlands.

The majority of the 1.1 million acres of National Forests in Florida consists of either pine flatwoods or wetland. Pine flatwoods are defined as "low-lying, dry timber land," or "level pineland occupying most of the Forida peninsula." I prefer the latter, since the word "dry" is inaccurate a majority of the time. I described at the beginning the major trees and grasses of the flatwoods.

While recognizing that cattle are opportunistic animals and will definitely utilize National Forest wetlands when they afford the most nutritious plants at the time, I'd like to discuss some National Forest management activities on our flatwoods sites.

Timber and range management activities are very compatible in the flatwoods. Both benefit greatly from periodic regeneration (as here by seed-tree method), fertilization (and here you see fertilized versus unfertilized), and prescribed burning. The predominant grass on these sites is wiregrass, a grass of limited palatability and nutrition to cattle, except for a very short time after prescribed burning. Frequent prescribed burning, spaced throughout the year, is a necessity in a successful forestland grazing program to increase palatability and nutrition of all grasses, and to allow more desirable grasses to temporarily compete with the dominant wiregrass.

A recent method of setting these prescribed fires by helitorch provides added benefit by producing varying microeffects caused by different intensities of heat the spots burn together. We believe this is advantageous to cattle and wildlife because of a greater diversity of vegetation resulting from the varying heat effects. Previous prescribed burning methodology consisted mostly of firing a series of parallel east-west fire lines and allowing the fire to back into a cold, north wind. This produces a mostly hemogeneous effect. The wetlands serve to contain the prescribed fire within the prescribed flatwoods area.

Site preparation for forest regeneration decreases wiregrass cover and allows other grasses to compete for a longer time than after fire, although on some sites some of these activities may decrease total grazable herbage for a period of time. On the other hand, Moore, Swindel, and Terry found species frequency increases following chopping on a north Florida flatwoods site of 3,000 percent for panicums, 173 percent on bluestems, 2,000 percent on rushes and sedges, and 308 percent on forbes.

Nearly all site preparation in the flatwoods is mechanical by shearing, disking, chopping, bedding, or some combination thereof. Shearing is rarely done any more. Disking is commonly with a D-7 and Rome TRH 14-30 harrow at about $35 per acre. Chopping is with a D-7 and Marden B-7 chopper filled with water at approximately $65 per acre for a double chop, or $35 for single. Bedding can be done with a D6 or large skidder and a 6 to 8 disk bedding plow with hour-glass packer for $60 per acre for double bedding, or $34 per acre for single. Vegetative response varies, of course, with method and/or intensity of site preparation.

Mechanical site preparation does not find favor with an increasing segment of the public, nor does reduction of the native wiregrass. One biological disadvantage of wiregrass reduction is that it is an excellent fire carrier as opposed to some of its competitors or replacements. We have seeded highly desirable forage grasses such as these examples of Pensacola Bahia, after site preparation on some sites at great advantage to cattle, and we need to continue to search for better forage grasses with overall ecological values equal to, or greater than, the native grasses. Here's an example of Bahia on specially prepared strips to supplement native forage, and a look at the intensity of grazing on it.

I said previously that the majority of National Forest land in this State is either wetlands or flatwoods. This means that there is quite an extensive perimeter of each, and along most of this perimeter is a transitional zone, or ecotone, or type interface -- whatever you want to call it. There are some interesting facts about this zone. First, it is probably our most fertile, readily manageable area. Second, in many places it is continually moving uphill onto higher flatwoods sites because of encroachment by titi, an invader species. Third, we have some interesting work going on in parts of this zone that has long-term significance for range management.

For many years we thought the most restricting factor to growth of trees on part of this zone was excessive moisture. This portion of the transition zone was characterized by large, open, poorly drained flats with heavy wiregrass ground cover and round-topped, small pines. The soil conditions and hydrophytic vegetation indicative of a wetland are absent on these areas. We found, however, that it was a phosphorus deficiency, not excessive moisture that caused a lack of tree growth. Fertilization with 300 pounds per acre of 18-46-0 gives phenomenal results on trees. Growth rings up to ½-inch are fairly common, although the average is considerably less. The nitrogen provides a synergetic effect with the phosphorus, and even though the nitrogen is used up the first year the phosphorus recycles for an unknown number of years. The fertilizer also provides added nutrition to browse and forage plants, but we have yet to determine these total effects. One year, because of contract difficulties, we did not apply the fertilizer until July. The result was the creation of a second springtime. New growth flourished. Application is by helicopter at $45 per acre, including fertilizer, and is one of the most cost-effective practices we do.

I've already alluded to the adverse effect of the absence of frequent, hot fires that historically burned through the flatwoods on a near-annual basis, and mostly during the growing season. The fire sub-climax that developed under such conditions favored cattle and some species of wildlife. Fires also retarded the advancement of titi that now covers 136,000 acres of the 560,000-acre Apalachicola National Forest.

With the advent of a fire protection program in the 1930's titi began its uphill march from occupation of a narrow riparian zone along streams, through tens of thousands of pine-grassland acres. This created another type of transition zone between flatwoods and wetlands, but one quite different from the poorly drained flats. Titi is an aggressive invader of no current commerical value, and with few weaknesses, the most significant of which is its relative intolerance to shade. On the other hand, titi completely wipes out all other understory species when it occupies a site. Fire and mechanical treatment only retard growth for a while, but can be used to slow further encroachment or to establish a stand of trees that will ultimately retard titi growth by decreasing available sunlight. Only then can some of the original understory be reestablished. We have such a program in progress.

Another interesting thing about this encroachment is the apparently lower evapo-transpiration rates of titi versus pine-grassland. Therefore, the titi areas are becoming wetlands. That these lands were once pine flatwoods is illustrated here by the significant number of residual slash pines remaining in the area even after titi encroachment.

We are currently trying to stop further encroachment by a program of pineland reclamation. Encroachment on the Apalachicola National Forest is currently occurring at a rate of 500 to 1,000 acres a year, so we try to mechanically site prepare an acreage in this range annually, and reestablish slash pine. Site preparation is normally by chopping, burning, chopping again, then bedding and planting. This is admittedly very costly, running in the $200-per-acre range, but must be measured against the annual cost of losing the management use of hundreds of acres.

As the slash pine has its dominance effect on the titi re-sprouts, we hope that previous understory plants will begin to reappear in a quantity to provide adequate fuel to re-institute a regular prescribed burning program. Some of these understory plants are still present in reclaimed areas, but not numerous in number. If our practices are successful, and we are aware that success or failure can only be determined after a considerable time, we will have reversed a process we consider detrimental to our range, wildlife, timber, and recreation management programs, and we will have reclaimed for production many acres capable of providing multiple resources needed by mankind.

I realize that I have broad-brushed a wide area concerning management of wetlands as we see it from a National Forest management perspective. That was, however, how I understood my charge here today -- to tell it from the practical management standpoint. To briefly summarize, I've described the general wetlands natural resource management situation in Florida as affected by laws and regulations, given you the National Forest perspective of our wetlands, and explained a few resource management practices favorable to grazing on, or adjacent to, wetlands. I thank you for your interest and entertain your questions.

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Workgroup Reports

Information and Publications

Dick Hallman, *Chairman*

Activities

1. The VREW 39th Annual Report on the February 10 - 11, 1985, Salt Lake City, Utah, meeting was prepared and 2,500 copies printed and distributed.

2. The agenda for the 40th Annual Meeting, February 9-10, 1986, Orlando, Florida, was prepared and distributed.

3. Two reports were distributed by the Missoula Equipment Development Center in rough draft form for review. Both will become chapters of VREW's new Range Structural Improvement Handbook which, when completed, will contain four chapters.

- Fences

- Other Structures

(Other chapters will cover various types of equipment and materials for water pumping and distribution)

4. Work has begun on an updated VREW slide program. The presentation will describe how VREW started, how it is organized, and show some of its many accomplishments.

Seeding and Planting

William J. McGinnies, *Chairman*

New Seed Drill

By Robert A. Teegarden, Bureau of Land Management, Billings, MT

The machine can be generally described as a nine-tooth heavy duty chisel plow with the chisels placed on 10-inch centers. We have 4½-inch spades mounted on each chisel shank. This gives us a 40 to 50 percent soil disturbance. Approximately one half of the disturbed soil is thrown over the undisturbed sod strip. The seed drop tubes and the packer wheels are in line with the chisel shovels. Thus, allowing seed to be dropped in the furrow, the packer wheel then presses the seed into the soil.

The entire unit is less than 9½ feet wide and can be towed behind a pickup.

The seeding unit consists of three seed boxes. A legume box, warm season grass box, and a cool season grass box. All three boxes run into a common drop tube assemble.

We have been chiseling to a depth of 4 to 6 inches. A 2-inch depth would probably be deep enough to reach the roots on blue grama and club moss, but we find that by going deeper we have a better seedbed to plant into.

The machine was designed and built by Truax Co., Inc., 3717 Vera Cruz Ave. North, Minneapolis, Minn. 55422; (612) 537-6639. The machine is in its later stages of development. We have two of the machines and have been furnishing Truax Co. research data. The second machine incorporates improvements identified in the first machine.

We did a number of acres last fall and got good moisture on the seeding. We hope to see some good results this spring.

There has been some criticism that the machine is too small to get any large acreage complete. We have observed that by increasing the speed of travel, the machine will fully tax a 150-horsepower tractor, and will cover 40 to 50 acres a day.

If you have further questions, do not hesitate to contact either Hubert Livingston, Big Dry Resource Area (406) 232-7000 or Mr. Truax.

A Heavy Roller For Seedbed Preparation and Hayland Preconditioning

By Paul E. Nyren, North Dakota State University, Streeter, ND

Various machines have been designed to prepare and firm seedbeds prior to planting. The rangeland cultipacker, brush roller, rangeland imprinter, auto tire packer, and various commercial cultipackers have all been used at one time or another to accomplish this job. It is also likely that similar machines were built in farm or agency shops designed to meet the needs of a specific task in a local area. Such a machine is the large roller described in this paper, which is used in the Coteau area of North Dakota to prepare the seedbed for grass and legume seeding and to recondition rocky hay ground.

This machine came to my attention shortly after moving to the Central Grasslands Research Station (CGRS) in 1981. The CGRS is located in south central North Dakota in the physiographic region known as the Missouri Coteau. The Coteau is an area of glacial stagnation characterized by rolling topography and rocky soils; therefore, rock picking is an annual event on much of the farmland in this area.

Four-foot-diameter roller used for seedbed preparation and hayland reconditioning.

The roller described in this article was constructed by an area rancher who discovered that an excellent seedbed could be prepared for a grass-alfalfa hay crop by using the large roller to firm the seedbed and to effectively eliminate rocks less than 12 inches in diameter rather than working an entire field with a rock rake and/or rock picker -- a costly operation. The fewer larger rocks could then be removed with a rock fork or other type of mechanical device mounted on a farm tractor.

The roller itself was constructed from a 3-foot galvanized culvert similar to those used in road construction. A used culvert was obtained and the frame built from used iron to reduce the cost of construction. Three-eighth or one-half-inch steel plate was cut to the diameter of the culvert and welded into the ends. An iron pipe was placed through the center of the culvert to add reinforcement. The bearings were salvaged from a truck rear axle and a housing was welded for them on each end frame. A shaft, the same diameter as the inside diameter of the bearing, was welded to the through pipe. The frame and tongue may be constructed from square tubing or used pipe, depending on cost or availability; however, ample bracing is essential for added strength since a roller of this size can place tremendous strain on the tongue and frame.

Once the component parts were assembled, the end pieces were welded to the culvert and the through pipe fitted and welded to the end pieces. A hole of ample size was cut into one end to facilitate adding the concrete. The culvert was then placed on end, filled with ready-mix concrete and left to harden. Once the concrete had cured, the roller was lowered and the frame fastened to the end bearings. Care must be taken to insure that no air pockets form between the concrete and the side of the culvert. If voids do occur, the culvert will soon become damaged in that area. If this should happen, a section of culvert material may be custom rolled and fitted over the damaged section, and welded into place after filling the void with cement.

Contrast between rolled seedbed ready for seeding on the right and untreated soil surface.

A 3-foot-diameter culvert-packer, 12 feet wide, will weigh approximately 14,500 pounds. The builders found that in using this equipment on soft, lighter soils, they sometimes had difficulty getting it to roll smoothly as a large amount of soil would be pushed along in front of the roller. The construction of a heavier roller using a 4-foot-diameter culvert solved this problem but increased the weight of the roller by 10,000 pounds. This roller can be pulled by a 130-horsepower, two-wheel-drive tractor equipped with dual rear wheels, but, some caution must be taken when turning especially on the down slope. Traction is also a problem on hills and many times these have to be rolled on the contour to avoid excess tire slippage. A four-wheel-drive tractor or one with front-wheel assist would be better suited to this task.

In addition to excellent seedbed preparation, it was found that the use of this roller minimizes the need for rock picking and eliminates rock damage to expensive seeding equipment. When used on ground that was dried on the surface, no undue compaction was found, and the seedbed produced was firm and fine. This type of seedbed, especially on fallowed ground, is very susceptible to wind erosion. If a press drill is used, the ridges left decrease the erosion somewhat, but the greater the quantity of litter left on the surface the better. When operating in recently tilled soils, the roller contacts the ground for approximately 3 feet of its circumference exerting a force of about 680 pounds per square foot, which is adequate to firm the seedbed and pulverize most soil aggregates.

The roller is also useful in smoothing older hay fields where frost has pushed rocks to the surface. This is best accomplished early in the spring when the ground is soft. In this case, a rock of 4 to 6 inches in diameter receives a force of at least 6 to 7 tons or 500 to 1,000 pounds per square inch. When the roller is operating on smooth ground, a force of about 14 pounds per square inch is exerted -- a force similar to that exerted by an ordinary farm tractor.

The cost of constructing a roller of this size will vary considerably, depending on the amount of used steel available. A 3-foot-diameter roller will hold approximately 0.26 cubic yard of concrete per foot of length while one with a 4-foot diameter will hold 0.46 cubic yard. At a weight of 4,000 pounds per yard, a 4-foot-diameter roller will weigh about 1 ton per foot of length.

Many variations of this type of roller are possible and may already exist at various locations. One such variation would involve constructing the roller out of an old boiler or heavy pipe and filling it with water rather than concrete. This would permit the roller to be drained and lightened for transport. This type of roller will generally be smooth rather than corrugated, but it is questionable whether the imprint left by the ridges on a corrugated roller serve any useful purpose.

On the left is a field where one round has been made with the roller.
On the right is the same field following rolling and seeding.

Coated Seed as a Tool for Revegetation

By Stu Barclay, CelPril Industries, Inc., Hermiston, OR

Background

Seed coatings have been in general use for about 20 years. The process originated in New Zealand, where there was a need to establish stands of legumes into soils with no native rhizobial bacteria to nodulate the plants. Most of these areas were seeded by aircraft, and the standard methods of inoculation were unsatisfactory; there was then no effective way to keep substantial counts of rhizobia on the seed.

A method was developed, whereby a coating consisting of very fine limestone was applied to the seed, using a water soluable adhesive. This coating surrounded the seed with a durable matrix, providing a medium which could carry not only very high counts of the essential bacteria, but other additives which the seeder could include at his discretion.

In addition, the process weighted the seed, increasing its density. Light, fluffy seed which was unable to flow, difficult to handle, and subject to wind-related dispersion problems could be broadcast effectively for the first time, when coated.

CelPril Industries, then Ramsey Seed Co., brought the coating process to the United States in the 1960's. Here, the coating process was developed for the agricultural market, chiefly for field crops such as alfalfa and clover. Through research and development, we have been able to establish coatings as a very effective management tool; in alfalfa stand establishment across the country, seedling survival has been increased by a factor of 53 percent, on average, where coatings are utilized. Through the inclusion of systemic fungicides in the coating, survivability has been pushed even higher in recent years. CelPril annually coats millions of pounds of alfalfas and clovers for these markets. Through the use of coated seed, growers are able to decrease their seeding costs, while realizing increased yields.

Advantages of Coatings for Revegetation

Seed coatings have properties which make them very useful in revegetation work, especially where broadcast seeding is utilized. Here are some of the principal advantages:

Increased Weight: Coatings can increase the seed's weight up to four times its original, or raw weight. This added density allows the seed to be thrown much further from broadcasting equipment, without modification. When aerial application is utilized, wind becomes much less a factor, and seed can be placed with much more accuracy. Because limestone or gypsum is used for the coating, the seed's size is not increased nearly as much as its density.

Coating as a Carrier: Seed coating provides a medium to carry any number of beneficial additives to aid in the seedling's survival. Very high counts of specially selected rhizobia, matched to the plant species, can accompany the seed to soils where such strains have never existed, providing legumes with the efficient nodulation which is so essential to their growth; studies have shown that well-nodulated plants can fix as much as 200 pounds of atmospheric nitrogen per acre in a season. This nitrogen is of great benefit to surrounding grasses, as well. Systemic fungicides can be included, to protect the young plant against soil-borne pathogens which are often present, particularly in wet environments. Micronutrients can be added, should soils be deficient. Florescent dyes can aid the seeding crew in seed placement, and allow the manager to check distribution and coverage. Plant nutrient can be applied to grass seed, affording a starter fertilizer capacity, which gives grasses a much better chance for survival where surface soil is deficient in nutrient. Grasses have become established for up to 55 days in pure Mount St. Helens Ash. Moreover, the limestone or gypsum coating has a pH balancing effect around the seed piece, when water melts the coating.

Water Attraction: Seed coating has a hydroscopic quality, drawing moisture to the seed as an aid to germination. This is particularly important when the seed is lying on the surface, and not drilled to an optimum depth. Even when seed is drilled, our research has shown that we can increase seedling survivability as much as 20 percent, taking only this quality into account.

Uses of Coated Seed in Revegetation to Date

Forestry: A number of districts have begun seeding their clearcut plantation units for brush control, since the banning of herbicides. A mix of grasses and legumes is broadcast from a "spin bucket" spreader beneath a helicopter. By coating the grass seed, the densities of the various seeds are equalized, allowing for a very even dispersal of different seeds throughout the unit, since they now throw the same distance. The legumes are inoculated through coating, and in some cases, potassium molybdate is added for acid soils. Those who have used the coating process are very pleased with the success it has afforded.

In California, a number of managers have had success in using coated seed for the reseeding of burned areas, where quick establishment was critical in avoiding erosion and mud slides during fall rains.

Bureau of Land Management: CelPril has coated a substantial amount of winterfat seed, a very fluffy, trashy seed. Coating gives this seed handling qualities and proper ballistics for aerial and spin spreader application. Range managers can now seed winterfat on a scale and at a rate previously unattainable.

Fertiblast and Coated Seed

The Fertiblast Gun was developed some years ago for the broadcasting of pellitized fertilizer, using compressed air. Fertilizer was able to be shot for a range of about 75 feet, using this method. Application of seed was not very effective, however, due to the low density of the material; at best, a range of 20 feet could be reached.

By coating the seed, the material is much denser, and a range of 35 to 45 feet can be accomplished. By including nutrient in the coating to achieve a starter fertilizer benefit, each seed carries with it about 55 days worth of nutrient, enough to carry it through most of its seedling stage. In most situations, this may be enough to get the plant well established.

The implication here is a much more cost effective means of revegetation, when compared to hydroseeding. The coating costs, when applied to the raw pound of seed, are from 45 cents to 1 dollar per pound, depending on seed type, and chemical or color added. The seed gun retails for about $175, and a fairly large compressor is needed (a trailer mounted unit, such as that used for a jackhammer, is required). With hydroseeding operations running between $500 and $1,000 per acre, the savings are substantial. Moreover, there is much more flexibility in using this method; the operation is very simple, so force account personnel can be utilized, and a unit with its own Fertiblast Gun can apply seed when it is needed, instead of risking the weather and other conditions to conform with the hydroseeding contractor's schedule.

Using coated seed with fertiblast will not, in and of itself, replace hydroseeding; it has its limitations. However, it has been indicated that the substantial portion of the revegetation work which *can* be done with fertiblast can be done so at great savings, and allow the manager to budget for a much greater area to be treated.

Summary

Coated seed provides a very useful tool to the revegetation manager. It allows for some very creative means of seeding, and can achieve results which can be accomplished in no other way. It offers a medium for any number of materials to be included in, and carried with the seed, to increase the odds for its survival and vigor.

CelPril has ongoing testing programs with State Departments of Transportation, Forest Service, Bureau of Land Management, and seeding contractors (USDA). Since these programs are quite new, there are still results pending.

For further information, contact Stu Barclay, western division sales manager, CelPril Industries, Inc., P.O. Box 276, Hermiston, OR 97838; (503) 567-7393.

Arid Land Seeding

Harold T. Wiedemann, *Chairman*

The workgroup devoted its efforts to grant support and the encouragement of seeding studies of various committee members. Grant funding was obtained for research to determine the amount of mass necessary for disk-chains to function adequately on native rangeland, and limited funding for the Range Improvement Machine (RIM seeder) for VREW observation. Plantings with the Range Improvement Machine have been installed and observations are available from Pat Currie, USDA-ARS, Miles City, MT. Chet Dewald, USDA-ARS, Woodward, OK, has been successful in developing grass seed conditioners and dehullers. His newly designed, low-pressure nozzle and curved air separation surface (coanda effect) has reduced power requirement by 85 percent compared to earlier models. This and other innovative seeding work is available from Chet. Victor Hauser, USDA-ARS, Temple, TX, has been involved with water injection when planting grass seed on arid lands. His paper No. 85-1517, "Water Injection in Grass Seed Rows," ASAE, St. Joseph, MI 49085, is very interesting. The disk-chain and other reports are covered separately.

Disk-Chain Performance

By Harold T. Wiedemann, Texas Agricultural Experiment Station, Vernon, TX

Studies have been conducted to project the optimum size disk-chain for use on native (undisturbed) rangeland infected with shrubs. Six disk-chains constructed from 1-7/8-, 2½- and 3-inch anchor chain and disk blade with diameters of 24 and 28 inches were used to evaluate the effect of mass on draft and depth of disk penetration. Operation widths for 20-blade units were 25.8, 33.5, and 39.5 feet for 1-7/8-, 2½- and 3-inch chains, respectively. A flexing, 20-inch-diameter roller developed for the triangular pulling technique provided the necessary flexibility for the disk-chain to operate properly on rough surfaces. Draft of disk-chains was positively correlated to operation mass and each pound of mass increased draft by 1.9 pounds of force. Draft was not significantly influenced by soil condition (cone index value). Depth of cut was best predicted by a regression equation that included the effects of disk-chain mass and soil cone index. The disk-chain with 3-inch chain and 24-inch disk blades (204 pounds per blade operating mass) had the best overall performance based on the broad range of soil conditions encountered in this study. Draft of this disk-chain pulled at 3 mph would be 380 pounds per blade plus or minus 14 based on prediction equation developed from actual data. These and other data are covered in ASAE paper No. 85-1612 (available from the author). This study was funded in part by VREW.

A disk-chain and flexing roller developed by the Texas Agricultural Experiment Station appears cost efficient for limited brush control and good seedbed preparation on rangeland infested with sagebrush or other shrubs. Average draft to pull the 39.5-foot-wide, 20-blade disk-chain made from 3-inch chain and 24-inch disk blades was only 7,600 pounds.

Establishment of Range Grasses on Various Seedbeds at Four Creosotebush Sites in Chihuahua, Mexico and Arizona, USA

By M.H. Martin, and F.A. Ibarra, Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora, J.R. Cox and H.L. Morton, Agricultural Research Service, Tucson, AZ

Three creosotebush study sites were selected in northern Mexico (La Reforma, Los Pozos, and El Toro) and one in southeastern Arizona (Santa Rita Experimental Range). Each study site was divided into two equal portions and twenty-four 50 by 100 meter plots were staked in each half. The following treatments (8), except land imprinting in Mexico, were applied in summer 1981 and at all sites in summer 1982:

A. Mechanical Treatments
   1. Two-way railing
   2. Land imprinting
   3. Disk plowing
   4. Disk plowing plus contour furrowing

B. Chemical Treatments
   5. Tebuthiuron at 0.5 kg/ha
   6. Tebuthiuron at 1.0 kg/ha
   7. Tebuthiuron at 1.5 kg/ha

C Untreated Check

The following grasses were hand broadcast at all sites in Mexico and drill seeded at SRER in 1981 with a rangeland drill immediately after seedbed preparation and both hand broadcast and drill seeded at all sites in 1982:

1. Lehmann lovegrass
2. Cochise lovegrass
3. Boer lovegrass "A-84"
4. Boer lovegrass "Catalina"
5. Kleingrass "75"
6. Sideoats grama "Premier"
7. Buffelgrass "Sonora" (on 1982 plantings only)

Successful plantings were obtained at SRER in both 1981 and 1982 and at El Toro in 1981. Plantings were unsuccessful in Mexico in 1982 because of extremely low rainfall. Tables 1 and 2 show the average amount of forage produced by planted grasses in 1984 on each seedbed treatment planted at SRER in 1981 and 1982 and at El Toro in 1981. The summer of 1981 at SRER was dry, but rain was adequate to pond water in the mechanical treatments. Seeds germinated in mid-July and died. Seedlings did not emerge in summer on herbicide plots but did in winter 1981-82. The amount and distribution of precipitation was ideal in 1982 and seedling emergence was generally the same in all seedbed treatments. Lehmann and boer (A-84) lovegrasses had difficulty emerging from these soils. Cochise and Catalina lovegrasses produced more forage than any of the other grasses, and both were growing during spring and fall when soil moisture was available (tables 3 and 4).

In 1981 seedling establishment and forage production at the four sites were superior on disk plowed and disk plowed and contour furrowed seedbeds, intermediate on chemical seedbeds, and least on two-way railed and land imprinted seedbeds. Kleingrass and sideoats grama were most abundant at sites that received summer precipitation (La Reforma and Los Pozos), while Catalina and Cochise lovegrasses were most abundant at sites that received both summer and winter precipitation (El Toro and SRER). Because of very dry conditions in 1982 and 1983, most of the species planted in 1981 died at the La Reforma and Los Pozos sites. Plant establishment was greater when seeds were broadcasted on the surface of mechanically prepared seedbeds.

Table 1. -- *Mean forage production (kg/ha) on eight seedbed preparations following drill seeding in either summer 1981 or summer 1982. The data were collected in fall 1984 at the Santa Rita Experimental Range, AZ.*

Treatment	Treatment Year 1981	1982
Two-way railing	1,200	1,600
Land imprinting	600	1,500
Disk plowing	1,000	2,150
Disk plowing plus contour furrowing	1,400	2,900
Tebuthiuron		
0.5 kg/ha	1,500	2,250
1.0 kg/ha	2,030	1,000
1.5 kg/ha	2,300	2,000
Untreated check	400	800

Table means are an average of all grasses on each treatment within the treatment year.

Table 2. -- *Mean forage production (kg/ha) on three seedbed preparations following hand broadcasting in summer 1981. The data were collected in fall 1984 at El Toro, Chihuahua, Mexico.*

Treatment	Treatment Year 1981
Two-way railing	10
Disk plowing	520
Disk plowing plus contour furrowing	520

Table means are an average of all grasses on each treatment within the treatment year.

Table 3. -- *Mean forage production (kg/ha) on eight seedbed preparations following drill seeding in either summer 1981 or summer 1982. The data were collected in fall 1984 at the Santa Rita Experimental Range, AZ.*

Grasses	Treatment Year 1981	1982
Lehmann lovegrass	150	950
Cochise lovegrass	3,510	4,170
Boer lovegrass "A-84"	370	800
Boer lovegrass "Catalina"	1,630	2,230
Kleingrass	1,100	1,340
Sideoats grama "Premier"	1,060	1,130
Buffelgrass "Sonora"	not seeded	1,840

Table means are an average of each grass from four mechanical and three chemical treatments applied within the treatment year.

Table 4. -- *Mean forage production (kg/ha) of seven range grasses following hand seeding in summer 1981. The data were collected in fall 1984 at El Toro, Chihuahua, Mexico.*

Grasses	Treatment Year 1981
Lehmann lovegrass	350
Cochise lovegrass	870
Boer lovegrass "A-84"	90
Boer lovegrass "Catalina"	360
Kleingrass	330
Sideoats gramma "Premier"	240
Buffelgrass "Sonora"	not seeded

Table means are an average of each grass from three mechanical treatments applied within the treatment year.

The Use of Fire, Grazing Livestock, Insecticides, and Plant Germplasm to Control Spittlebug in Buffelgrass Pastures of Northern Mexico

By I. Cazares, M.H. Martin, and F.A. Ibarra, Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora; J.A. Morales, Instituto Tecnologico y de Estudios Superiores de Monterrey, Monterrey, Nuevo Leon; H.L. Morton and J.R. Cox, Agricultural Research Service, Tucson, AZ

Buffelgrass(Cenchrus ciliaris), a perennial bunchgrass, was introduced into Sonora, Mexico from the United States in 1954. Since introduction, the grass has been successfully established on over 300,000 hectares and has potential for establishment on an additional 3 million hectares. Buffelgrass forage production exceeds that of native grasses, and stocking rates on buffelgrass pastures have been as high as 10 times greater than on native pastures.

Spittlebug (Aeneolamia albofasciata) feeds on buffelgrass and its populations have dramatically increased in Sonora over the past 3 years as a result of above average precipitation. Adults and nymphs extract fluids from buffelgrass and adults inject a toxin into the plant. Feeding spittlebugs can significantly reduce the quality and quantity of buffelgrass forage and may in some instances kill plants. Sonoran cattlemen fear that their productive buffelgrass pastures will be destroyed and have requested that we develop and test methods that can economically control spittlebug populations.

The following studies were initiated in 1984-85 to determine their effects on spittlebug populations and the productivity of buffelgrass:

Application of Fire

Fire seems to be an adequate and economical practice that ranchers can use in buffelgrass pastures to reduce high spittlebug populations. Unfortunately, data on buffelgrass productivity as influenced by season of burning are unavailable. This study has been divided into three parts:

- Effects of different seasons of burning on spittlebug populations in buffelgrass pastures.
- Effect of summer burning on the life cycle of spittlebugs.
- Effect of different seasons of burning on buffelgrass productivity.

Preliminary results indicate that burning before the rainy season or in the early stages of the spittlebug life cycle has caused the most damage to both eggs and nymphs. Adult spittlebugs prefer to feed on regrowth of burned buffelgrass plants; however, reproduction does not occur because fire has destroyed the old plant material and the habitat necessary for egg laying and other reproductive processes. A few nymphs of spittlebug are found in burned areas on plants that escaped the fire.

Grazing Management

Some ranchers prefer to use grazing management rather than fire to reduce the size of plants and the litter which provide ideal conditions for spittlebug populations. We are studying the effects of different levels of buffelgrass utilization by livestock during the summer growing season and determining the effect of grazing on spittlebug populations. Preliminary results indicate that a rotation grazing system that removed about 60 percent of the biomass during the summer growing season has destroyed the environmental conditions required for the spittlebug development. Nevertheless, some plants in heavily grazed pastures will not be grazed by cattle, and the plants that are not grazed tend to provide suitable conditions for spittlebug development. Although damage from spittlebugs on a very well-grazed pasture is not significant compared with the light grazing and ungrazed pastures, it is possible that these ungrazed plants will provide a breeding population for the future.

Application of Insecticides

In Mexico, insecticides are too expensive to be applied over vast areas of rangeland. However, they can be used on small areas that have high spittlebug populations and potential for spread to uninfested areas. The insecticides Carbaryl, Malathion and two pyrethrin compounds (Ambush and Cimbush) were applied at different rates as spot treatments during the months of July, August, and September to evaluate spittlebug susceptibility during the life cycle. Preliminary results indicate that early application of insecticides between the first and fourth instar stages are more effective than application in the adult stages.

Development of Buffelgrass Accessions Resistant to Spittlebug

We are working with five buffelgrass accessions (H-28, H-45, H-7, H-4, and H-3) that produce less aboveground biomass than common buffelgrass and from studies in Nuevo Leon are known to be less susceptible to spittlebug attack. These accessions were planted in the field to determine establishment potential. Later we will select one or two accessions that are easily established and determine if they are more resistant to spittlebug feeding and reproduction than common buffelgrass in Sonora.

Chemical and Mechanical Brush Control and the Response of Native Grasses in the Chihuahuan and Sonoran Desert

By R.A. Ibarra and M.H. Martin, Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora;
H.L. Morton and J.R. Cox, Agricultural Research Service, Tucson, AZ

By F.A. Ibarra and M.H. Martin, Centro de Investigaciones Pecuarias del Estado de Sonora, Hermosillo, Sonora;
H.L. Morton and J.R. Cox, Agricultural Research Service, Tucson, AZ

Creosotebush (Larrea tridentata), either alone or in combination with other shrubs, infests from 18 to 26 million hectares in the southwestern United States and 45 million hectares in northern Mexico. Chemical and mechanical treatments were applied during summer of 1981 and 1982 at three field sites in Chihuahua and one in Arizona. Treatments were: tebuthiuron at 0.5, 1.0, and 1.5 kg a.i./ha, land imprinting, two-way railing, disk plowing, and disk plowing plus contour furrowing. Treatments were evaluated for creosotebush mortality and forage production for three growing seasons after treatment.

Data obtained for both brush mortality and forage production were variable within locations, between locations, and years of application due to different soils, vegetation, and climate. Disk plowing treatments and tebuthiuron applied at rates of 1.0 and 1.5 kg a.i./ha gave the greatest brush mortality at all locations (table 1). Total forage production by annual and perennial plants 3 years after treatment is presented in table 2.

Production by annual grasses tended to be greater on the mechanically treated areas than on the chemically treated and untreated checks. During the first and second years after tebuthiuron application forage production by annual grasses was lower than untreated checks but was higher during the third year after application. Forage production of perennial grasses tended to be greater on chemically treated areas than on mechanically treated and untreated checks. Soil disturbance on the mechanical treatments resulted in destruction of many perennial grasses at all locations.

Total forage production was significantly improved at three out of the four locations (table 2). Mean total forage production for 1981 and 1982 at La Reforma was increased from 55 to 111 percent with the mechanical treatments and from 136 to 230 percent with the chemical treatments. At Los Pozos forage production was increased from 43 to 167 percent on the mechanically treated areas and from 137 to 247 percent on the chemically treated areas. At El Toro forage production was reduced from 16 to 60 percent on the mechanically treated plots and was increased from 20 to 37 percent on the chemically treated plots. At the Santa Rita Experimental Range (SRER) forage production was increased from 94 to 264 percent on the mechanically treated plots and from 153 to 213 percent on the chemically treated plots. Creosotebush infested rangelands in the Southwest United States and northern Mexico can be converted back to productive semidesert grasslands with chemical and mechanical practices.

Table 1. -- *Mean creosote bush mortality (%) in 1984 after treatments applied in 1981 and 1982 at four locations.*

Treatments	Locations: La Reforma, Chihuahua	Los Pozos, Chihuahua	El Toro, Chihuahua	SRER, Arizona
Tebuthiuron				
0.5 kg/ha	44	58	84	50
1.0 kg/ha	65	78	97	83
1.5 kg/ha	86	91	99	92
Land imprinting	15[a]	12[a]	20[a]	13
Two-way railing	30	47	21	26
Disk plowing	67	65	88	80
Disk plowing plus contour furrowing	69	64	91	77

[a] Data from 1982 treatments only.

Table 2. -- *Mean forage production (kg D.M./ha) 3 years after application of seven treatments applied in 1981 and 1982 at four locations.*

Treatments	Locations: La Reforma Chihuahua	Los Pozos Chihuahua	El Toro Chihuahua	SRER Arizona
Tebuthiuron				
0.5 kg/ha	584	320	802	666
1.0 kg/ha	757	326	697	550
1.5 kg/ha	817	330	761	680
Land imprinting	448[a]	254[a]	486[a]	490
Two-way railing	383	136	234	791
Disk plowing	490	148	249	423
Disk plowing plus contour furrowing	523	224	382	451
Check	247	95	583	217

[a] Data from 1982 treatments only.

Mechanical Plant Control

Gus Juarez, *Chairman*

(Reported by Dan W. McKenzie, Forest Service,
San Dimas, CA)

The Beckwourth and Quincy Ranger Districts of Blairsden and Quincy, CA, on the Plumas National Forest operated a Madge Rotoclear land breaking machine under contract this last summer. The machine was pulled by a Caterpillar D-6 tractor. Operating speed was just over 1 mph, which resulted in a production rate of 1/2 to 3/4 acre per hour. The unit was able to operate in ground containing a fair amount of rocks surprisingly well.

Problems with the machine were the great amount of dust, loss of teeth, and the machine's lack of preventative maintenance before being placed into operation. After a heavy rain the dust problem did not exist. The operation was discontinued after a severe breakdown and contract problems. Approximately 10 acres were treated in 17 hours of operation. Basic contract cost was $95 per operating hour for the machine. Other costs were fuel, towing tractor, operator, swamper crew pickup, and move in and out costs.

The machine used on the Plumas National Forest was obtained from a Canadian contractor. The Mechanical Plant Control Workgroup Chairman has since learned that a U.S. contractor is operating three Madge Rotoclear units in the United States and that cost of operation, depending on location and size of job, ranges from $100 to $200 per hour, or $100 to $175 per acre. The U.S. contractor is:

Robert Van Houten
Great Lakes Land Breaking
8880 West County Line Rd.
Marion, MI 49657

Telephone: (616) 825-2804

Teeth of Madge Rotoclear land breaking machine. These teeth can operate in material that can be cut with a hand ax.

Madge Rotoclear in operation on the Plumas National Forest, California.

Structural Range Improvements

Billy H. Hardman, *Chairman*

Avery Stroke Control Device for Windmills

By Robert G. Childress, Forest Service, Hot Springs, SD

An ingenious device that increases the capability of a windmill to pump water has been tried. It was invented by Dr. Don Avery, Professor Emeritus of Mechanical Engineering, University of Hawaii. It automatically controls the length of a windmill's stroke to increase the amount of water pumped when windspeed increases.

On a conventional windmill, the length of the stroke is constant. When windspeed doubles, the windmill pumps more water because the number of strokes per minute increases. But it could do more. Actually, the power of the wind is approximately proportional to the cube of the windspeed. The device uses the additional power by automatically changing the length of the windmill stroke, depending on windspeed. At very low windspeeds, when a windmill normally wouldn't turn, the stroke is short but it does pump a little water. When the wind blows harder, the device changes the stroke to a long stroke. So not only does the windmill turn faster with more wind, it also pulls a longer stroke and therefore pumps more water -- actually about four times the amount of a conventional windmill.

The particular device is a shop-built prototype made by Dempster Industries of Beatrice, NB. The prototype was installed on the Rita Blanca National Grassland in Texline, TX. It was installed on an 8-foot Aeromotor windmill over a well with a total depth of 120 feet. Water level is 52 feet and the well can produce over 20 gallons per minute. The well has 2½-inch steel tubing with a 2¼- by 24-inch brass cylinder set at 70 feet. The windmill is set at the long stroke -- 8 inches. Without the device, the windmill produced about 4 gallons per minute in a 15-mph wind. With the device at the same windspeed, we get close to 17 gallons per minute. The stroke varies from 2 to 16 inches with the device.

So it works. Is it economically feasible? If the device could be commercially manufactured and installed and maintained for less than the price of the next best alternative, it would be feasible. At this time, if more water is needed from a well, the thing that is normally done is to replace the windmill with a larger head. The cost would probably be at least $1,000 and maybe several times more. It should be possible to install a commercially manufactured kit for considerably less than $1,000.

Diagonal Fence Strainer Use and Other Fence Developments

By Dan W. McKenzie, Forest Service, San Dimas, CA

The diagonal fence strainer (fig. 1), which is equal in strength and holding force to the horizontal fence strainer (fig. 2) but is lower in cost to install, is gaining in use. When using the diagonal fence strainer two important rules should be followed:

1. Be sure that the end of the diagonal brace in contact with the ground is free to move forward and is *not* blocked by a stake or post.

2. Make the diagonal brace as long as possible (at least 8 feet; 10 feet is better and, if possible, 12 feet). This rule applies to the horizontal strainer also.

One situation where very good use can be made of the diagonal strainer is to prevent fence failures at dog legs. The failures can be eliminated by placing a diagonal strainer so that it bisects the dog leg angle (see fig. 3).

In constructing either a diagonal or horizontal type fence strainer, one of the most important features is the length of the strainer. When a strainer is 10 to 14 feet long it will not fail by end or corner post pull out. If strainers are soundly constructed 10- to 14 feet long, the need for double strainers appears to be unnecessary, thus eliminating their added cost.

In fence building, one high labor cost item is the construction of conventional horizontal line strainers (fig. 4), usually every quarter of a mile in a barbed wire fence. A design of a line strainer that allows a significant reduction in the amount of construction labor and material is the tension member line strainer (fig. 5). A tension member line strainer requires only one post hole to be dug and the use of one post; the bottoms of the next posts are used to anchor the tension members.

Recently the aligned Fiber Composites (AFC) Co. (Highway 52, South Chatfield, MN 55923, telephone: 507/867-3479) completed the development of a fencing system using fiberglass posts and specially designed hardware (fig. 6). They have prepared a very good installation manual for the system, which they will send upon request.

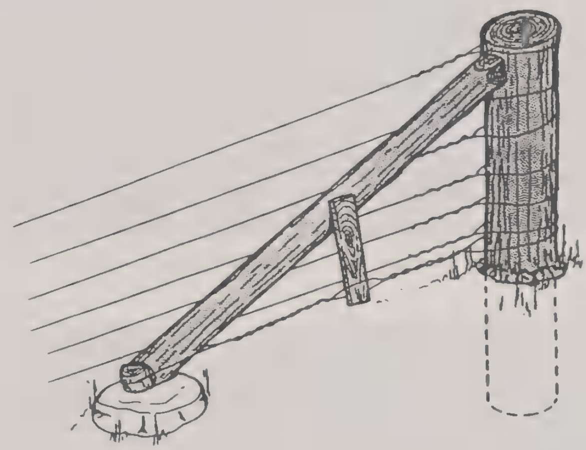

Figure 1.—Diagonal fence strainer that is equal in strength and holding force to the horizontal fence strainer, but costs less to install.

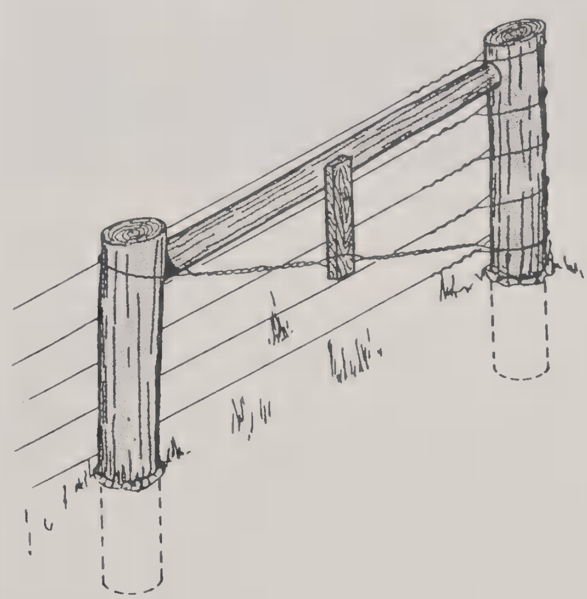

Figure 2.—Horizontal fence strainer.

Figure 3.—Diagonal fence strainer in use at a dog leg.

Figure 5.—Tension member line strainer.

Figure 4.—Conventional horizontal line strainer.

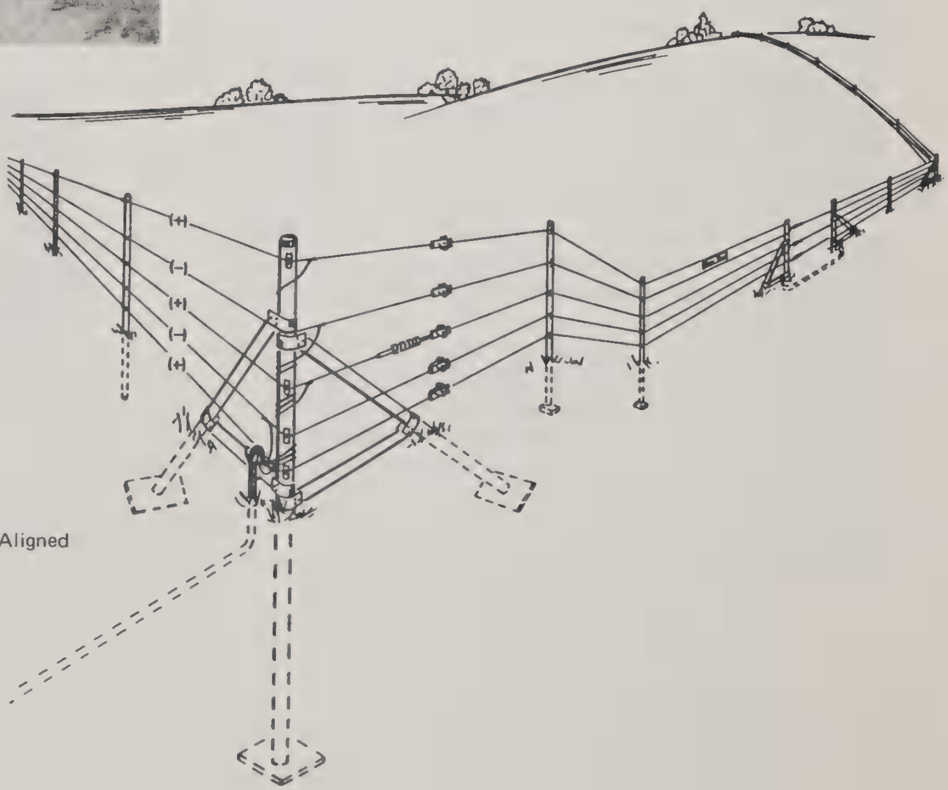

Figure 6.—Recently developed fencing system from Aligned Fiber Composites (AFC) Co.

Range Structural Equipment Handbook

By Billy H. Hardman, Forest Service, Missoula, MT

Each Federal agency involved in range management activities has one or more structural improvements handbooks. Eight of the nine Forest Service Regions have their own handbooks. VREW participants felt strongly that a national handbook would benefit range managers.

Missoula Equipment Development Center personnel began the project by meeting with the Structural Range Improvements Workgroup to determine content and draft an outline. It was agreed the handbook would consist of four main sections: Fencing; other structures; water -- part I; water -- part II.

The fencing and other structures portions of the handbook are now complete and have been sent out for technical review. The goal is to publish them in FY 1987. Work on the water sections of the handbook will be started as soon as possible. It is hoped a rough draft can be compiled by the end of FY 1987.

Equipment Development and Test Funding

Planning and Budgeting Procedure

For many years the "Range Reseeding Committee" was an informal group, meeting each year to exchange information on work of mutual interest and to develop project proposals for work to be done by Equipment Development Centers or field units. The proposals were written, estimated for cost, and finalized "on the spot." Informal but it seemed to work!

Today there are demands being placed on us to plan in detail 2 years in advance, and in general 5 to 10 years ahead. This does take away some of the informality of the operation and dictates the need for a more organized approach to the preparation and submittal of project proposals. Figure 1 shows a plan by which we can meet our budgeting dates. It provides a mechanism whereby the Equipment Development Centers can stay with the budget process of the Forest Service.

The other aspect of our planning procedure is a more uniform format for project proposals. Figure 2 is a suggested guideline for proposals. Following this guide will help all concerned in preparing and reviewing proposals. It should make the flow of information more efficient and provide a much better story for those who must analyze needs, prepare programs, and assign priorities.

We hope that everyone associated with the Vegetative Rehabilitation and Equipment Workshop will cooperate in this more formal approach. It should be an aid to everyone. If any questions arise or there is a need for help in this process, call the Centers or the Washington Office.

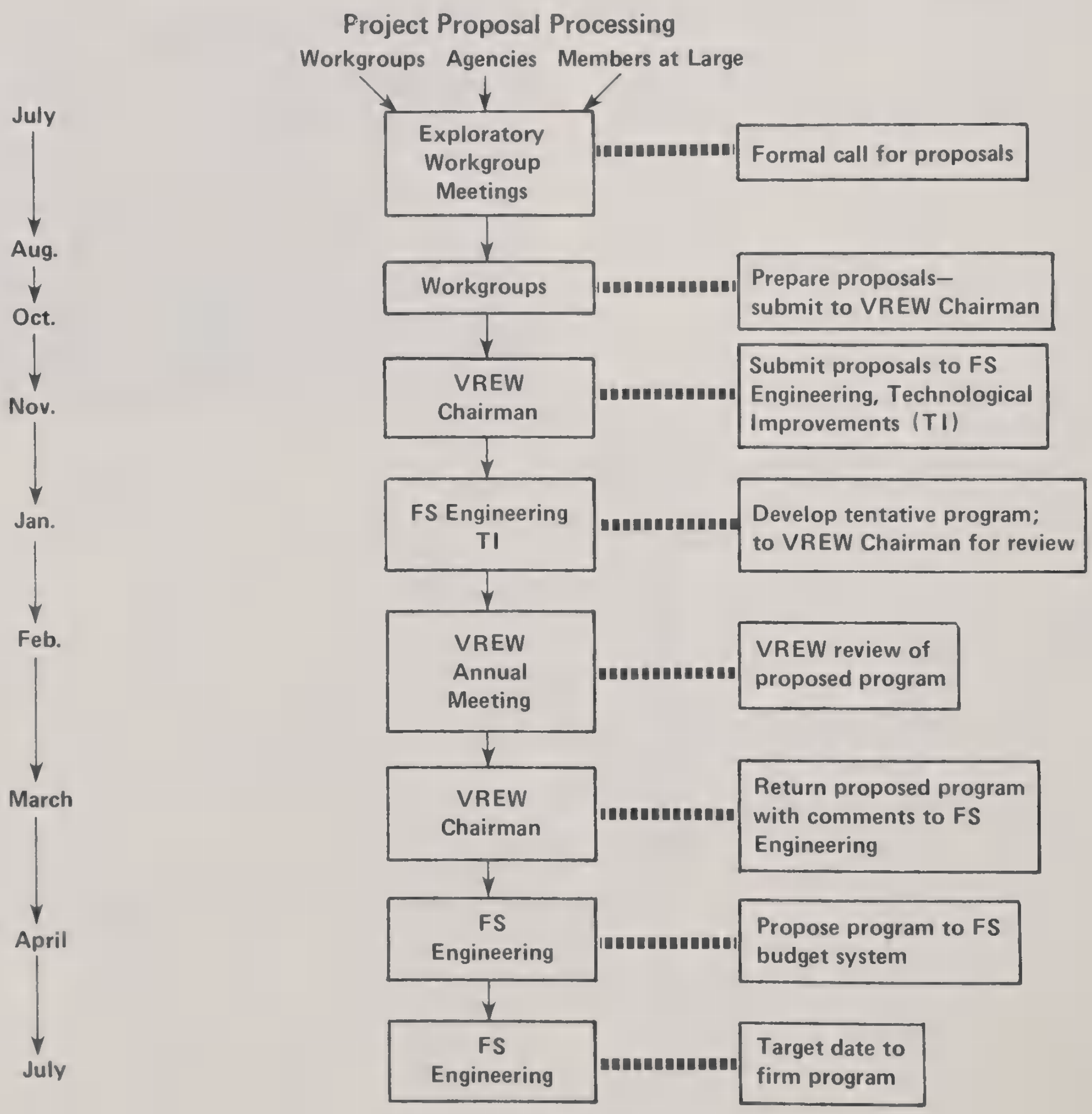

Figure 1.—Project proposal processing.

(PROJECT PROPOSAL FORMAT)

EQUIPMENT DEVELOPMENT AND TEST PROJECT PROPOSAL FOR FY ____

ED&T Project No. (Leave Blank)
Date ________________
Primary Interest: ________

____
(TITLE)

- *(The title should be brief and indicative of project objectives.)*

PROBLEM STATEMENT AND OVERALL OBJECTIVES

- *(State the problem and describe how the work is currently being done. Tell what equipment, materials, or methods are used, and why change or improvement is needed. Show significant advantages and potential savings, such as: increased production or efficiency, property or human hazard reduction, reduced maintenance, and public demand or reaction.)*

- *(State the overall objectives. What is to be accomplished or what is to be achieved by this project?)*

- *(Include amendments to the problem statement and overall objectives, if necessary (for completion by the Development Centers for applicable continuing projects only). The statements of the original problem and objectives should not be changed. If there is a change in emphasis, add revised problem statements and objectives here.)*

SPECIFIC REQUIREMENTS

- *(Distinguish between minimum requirements and those which are desired but not essential. Describe features required or specify performance characteristics. Where more information will be needed but cannot be furnished, list items that should be explored.)*

PRIOR DEVELOPMENT

- *(Briefly describe work already completed or underway which is related to this project. On new projects, this work will generally have been done by other persons or organizations or under other equipment development projects. For a continuing project, tell when it started and briefly state major accomplishments, and actions planned for completion in the current fiscal year. Reference the overall project time frame and total cost estimate if previously made and if applicable, prior reports and publications.)*

PROJECT ORIGIN

- *(Show the name, organization, etc. of persons originating the project and preparing the project proposal.)*

Figure 2.—Format for project proposal.

FY 1986 Program
Missoula Equipment Development Center

Number	*Project*	*Amount*
7E72D22	VREW Information Workgroup Support	$ 19,200
4E42D29	Browse Seed Harvester	22,100
4E42E30	Disk Chain Implement	7,900
5E42D31	Range Structural Equipment Handbook	22,800
TE02015	Technical Services, Range	18,000
		$ 90,000

Range Publications and Drawings

Below are titles of reports on a variety of range rehabilitation topics, as well as a list of range equipment fabrication drawings. These materials have been produced by the Forest Service Equipment Development Centers at Missoula (MEDC) and San Dimas (SDEDC) and may be of interest to workshop members. Single copies of the reports are available without charge by writing to the appropriate Center. Some drawings are available without cost also; there may be a small charge for others.

Forest Service, USDA
Equipment Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801

Forest Service, USDA
Equipment Development Center
444 East Bonita Ave.
San Dimas, CA 91773

The list of publications includes *Equip Tips,* concise reports dealing with new equipment, new uses for equipment, and similar topics; *Equipment Development & Test (ED&T) Reports*, documenting major development studies; *Project Reports,* describing the technical details of development work, including procedures, results, conclusions, and recommendations; a number of special reports, ASAE papers, and service manuals are listed under "Other Reports."

Equip Tips

Hydraulic Post Puller, Aug. 1984—MEDC

Bitterroot Miniyarder for Light Forest Materials, May 1983—MEDC

Small Yarder for Steep Terrain, May 1981—MEDC

Resource Publications, Dec. 1980—MEDC

Proper Use of Fusees, Feb. 1980—MEDC

Improved Aerial Ignition System, Jan. 1980—MEDC

Protecting Western Conifer Seedlings, May 1979—MEDC

Steep-Slope Seeder for Roadside Slope Revegetation, Feb. 1979—SDEDC

Improved Method for Joining Plastic Pipe, Dec. 1978—MEDC

Seed Dribblers (revision no. 1), July 1977—SDEDC

Spray Boom Assembly, July 1972—SDEDC

Plastic Pipe Laying Machinery, Jan. 1966—SDEDC

Browse Seeder with 20-inch Scalpers, Jan. 1965—SDEDC

ED&T Reports

Catalytic Converter Exhaust System Temperature Tests, Feb. 1977—SDEDC

Slash . . . Equipment and Methods for Treatment and Utilization, April 1975-SDEDC

Clearing, Grubbing, and Disposing of Road Construction Slash, Oct. 1976—SDEDC

Roadside Slope Revegetation, June 1974—SDEDC

Flexible Downdrains, Jan. 1974—SDEDC

Tractor Attachments for Brush, Slash, and Root Removal, Jan. 1971—SDEDC

Results of Field Trials of the Tree Eater, Jan. 1970—SDEDC

Forestland Tree Planter, Sept. 1967—SDEDC

Pine Seed Drill, Sept. 1967—SDEDC

Project Reports

Revegetating Slopes with Geotextiles and Geogrid Systems, Sept. 1985—MEDC

Premo Mark III Aerial Ignition System, May 1985—MEDC

Range Water Pumping Systems—State-of-the-Art-Review, Feb. 1985—SDEDC

Field Equipment for Precommercial Thinning and Slash Treatment, Jan. 1984—SDEDC

Analysis of Spray Deposit Cards Sensitive to Nondyed Sprays, Feb. 1984—MEDC

Preventing Livestock Water from Freezing, Nov. 1983—SDEDC

Rangeland Fencing Systems State-of-the-Art Review, Oct. 1983—SDEDC

Evaluation of the Pettibone Slashmaster Model 900 for Site Preparation in the Lake States, Feb. 1983—SDEDC

Dryland Plug Planter, Dec. 1982—MEDC

Tree-Planting Machine—How Much Can You Afford to Pay for One?, June 1981—SDEDC

Sod Mover Bucket, Dec. 1980—MEDC

Tree/Shrub Planter for Roadside Revegetation, Oct. 1980—SDEDC

Observations on Operations of the Pettibone Hydro-Slasher PM 800, Feb. 1980—SDEDC

Basin Blade for Disturbed Land Revegetation, Nov. 1979—MEDC

Plastic Tubes for Protecting Seedlings from Browsing Wildlife, July 1979—MEDC

Mulching-Tilling Equipment for Soil Conditioning, Jan. 1979—MEDC

Evaluating Methods for Joining Polyethylene Pipe, Dec. 1978—MEDC

A Transplant System for Revegetating Surface Mined Lands, Nov. 1978—MEDC

Grapples for Forest Residues Concentration and Removal, Oct. 1978—SDEDC

Field Equipment for Precommercial Thinning and Slash Treatment, July 1978—SDEDC

Modified Hodder Gouger, Dec. 1977—MEDC

An Investigation of Equipment for Rejuventating Browse, Aug. 1977—MEDC

Survey of High-Production Grass Seed Collectors, Jan. 1977—SDEDC

Remote Sensing for Big Game Counts, Dec. 1976—MEDC

Evaluation of the Vermeer Model TS-44A Tree Spade for Transplanting Trees on Surfaced Mined Land, Feb. 1976—MEDC

Wildlife Habitat Management Needs, Oct. 1975—MEDC

Using Heat for Sagebrush Control, Feb. 1972—MEDC

Other Reports

39th Annual Report—Vegetative Rehabilitation and Equipment Workshop, Dec. 1985—MEDC

Low-Cost Diagonal Fence Strainer (ASAE paper No. 84-1624), Dec. 1984—SDEDC

Improved and New Water Pumping Windmills (ASAE paper No. 84-1625), Dec. 1984—SDEDC

38th Annual Report—Vegetative Rehabilitation and Equipment Workshop, Nov. 1984—MEDC

Reclaiming Disturbed Lands, Nov. 1984—MEDC

Manual of Revegetation Techniques, May 1984—MEDC

37th Annual Report—Vegetative Rehabilitation and Equipment Workshop, Oct. 1983—MEDC

Development of a Containerized Shrub Injection Planter Attachment for a Backhoe—A Prospectus, Jan. 1983—SDEDC

Dryland Plug Planter—Operator's Manual, Jan. 1983—MEDC

History of the Vegetative Rehabilitation and Equipment Workshop (VREW) 1946-1981, Dec. 1982—MEDC

36th Annual Report—Vegetative Rehabilitation and Equipment Workshop, Sept. 1982—MEDC

Punch Seeder for Arid and Semiarid Rangelands—A Prospectus, Sept. 1982—SDEDC

Development of A Disk-Chain Implement for Seedbed Preparation on Rangeland—A Prospectus, July 1982—SDEDC

Arid Land Seeder Development—A Prospectus, July 1982—SDEDC

Equipment for Containerized Tree Seedlings, July 1982—MEDC

Catalog for Hand Planting Tools, May 1982—MEDC

Sources of Seed and Planting Stock, Oct. 1981—MEDC

Sod Mover Operator's Manual, Feb. 1981—MEDC

Development of a Rangeland Interseeder for Rocky and Brushy Terrain (ASAE paper 80-1552), Dec. 1980—SDEDC

Equipment for Reforestation and Timber Stand Improvement, Oct. 1980—Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; Request Stock No. 001-001-00563-1; $6.50.

34th Annual Report—Vegetative Rehabilitation and Equipment Workshop, Sept. 1980—MEDC

Modified Basin Blade—Operator's Manual, Mar. 1980—MEDC

Sodder brochure, Mar. 1980—MEDC

Basin Blade brochure, Mar. 1980—MEDC

Mulching-Tilling System brochure, Mar. 1980—MEDC

Transplanting System brochure, Mar. 1980—MEDC

Sprigger brochure, Feb. 1980—MEDC

Dryland Plug Planter brochure, Feb. 1980—MEDC

Revegetation Equipment Catalog, Feb. 1980—MEDC

Agricultural Engineer's Role in Rangeland Improvement and Rehabilitation Equipment (ASAE paper 79-161), Dec. 1979—SDEDC

Observations on Operations of a Residue Shredder and a Brush Harvester, Sept. 1979—SDEDC

33rd Annual Report—Vegetative Rehabilitation and Equipment Workshop, July 1979—MEDC

Front-End Loader Tree Spade—Manual Supplement, Feb. 1979—MEDC

35th Annual Report—Vegetative Rehabilitation and Equipment Workshop, Sept. 1981—MEDC (Available from National Technical Information Service (NTIS) U.S. Department of Commerce, Springfield, VA 22161 for $10.50 in paper and $4.00 in microfiche.)

Concepts—Sod Mover, Aug. 1978—MEDC

Aerial Burning Equipment for Plant Control, Feb. 1977—MEDC

Handbook—Equipment for Reclaiming Strip Mined Land, Feb. 1977—MEDC

Rangeland Drill Operations Handbook, BLM Tech. Note 289, Sept. 1976—SDEDC

Evaluation of the "Vari-Dozer," Feb. 1974—SDEDC

Investigation of Selected Problems in Range Habitat Improvement, Feb. 1974—SDEDC

History—Range Seeding Equipment Committee 1946-1973, Jan. 1974—MEDC

Results: 1972 Range Improvement Survey (27th annual Range Seeding Equipment Committee report), Feb. 1973—MEDC

Implement-Carrying Hitch for Forestry Use (ASAE paper), Dec. 1972—SDEDC

Efficiency and Economy of an Air Curtain Destructor Used for Slash Disposal in the Northwest (ASAE paper), Dec. 1972—SDEDC

Service & Parts Manual for the Contour Furrower Model RM 25, June 1970—SDEDC

Service & Parts Manual for the Brushland Plow, June 1968—SDEDC

Service & Parts Manual for the Rangeland Drill Models PD-10x6 and B-20x6, Aug. 1967—SDEDC

Other Publications of Interest to VREW

Private Water Systems Handbook, Midwest Plan Service, Iowa State University, Ames, IA 50011. $2.50

Water Systems Handbook (7th Edition), Water Systems Council, 221 North La Salle St., Chicago, IL 60601. $6

Water Well Handbook, Keith E. Anderson, Missouri Water Well and Pump Contractors Association, Inc., P.O. Box 517, Belle, MO 65013. $10

Evaluation of Pumps and Motors for Photovoltaic Water Pumping Systems, David Waddington and A. Herievich, Solar Energy Research Institute. Available from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161. $3 microfiche; $5.25 printed copy

Rangeland Drill, reprint from "Rangelands," vol. 4, no. 3, June 1982.

Glossary of Surface Mining and Reclamation Terminology, Bituminous Coal Research, Inc., 350 Hochberg Rd., P.O. Box 278, Monroeville, PA 15146. (412) 327-1600. $2

Range Development and Improvements, 2nd edition, J.F. Vallentine. 1980, Brigham Young University Press, Provo, UT 84602. 545 pp. $18.95.

How to Build Fences with Max-ten 2—High Tensil Fence Wire, U.S. Steel Corp., P.O. Box 86 (C-1424), Pittsburgh, PA 15230. $5 plus $1.50 postage and handling

How to Design An Independent Power System, Terrance D. Paul, Best Energy Systems for Tomorrow, Inc., P.O. Box 280, Necedah, WI 54646, (608) 565-7200. $4.95

From American Association for Vocational Instructional Materials (AAVIM) Engineering Center, Athens, GA 30602:

Planning for an Individual Water System, No. 600, $6.95

Planning Fences, No. 404, $4.25

Building Fences, No. 405, $4.25

(For orders less than $10 add $1 for postage and handling; for orders over $10 add 8 percent for postage and handling.)

Range and Pasture Seeding in the Southern Great Plains, Proceedings of a symposium on the newest grasses, seeding techniques, and seed harvesting/processing equipment, Oct. 19, 1983, Vernon, TX 76384, Texas A&M Univ., Agricultural Research and Extension Center, Vernon, TX, 115 pages, $5.00. Order Seeding Proceedings Attn: Harold Wiedemann, Texas Agricultural Experiment Station, P.O. Box 1658, Vernon, TX 76384

Windmills and Pumps of the Southwest, Dick Hays and Bill Allen, Eakin Press, P.O. Box 23066, Austin, TX 78735, 110 pp. $7.95

Electric Fencing for Rangelands, Special Series 27, Colorado State Univ., Agricultural Experiment Station, Fort Collins, CO. Order from Bulletin Room, Colorado State Univ., Fort Collins, CO 80523, (303) 491-6198, $3.25 post paid

Small-Scale Solar-Powered Pumping System: The Technology, Its Economics and Advancement; main report by Sir William Halcrow and Partners in association with Intermediate Technology Power, Ltd., for the World Bank under project UNDP Project GLO/80/003, June 1983

Farm Show, published bimonthy by Farm Show Publishing, P.O. Box 704, Lakeville, MN 55044, (612) 469-5572, $9.95/year

Drawings at SDEDC

Pipe Harrow, RM1-01 and 02

Brushland Plow, RM2-01 to 22

Oregon Press Seeder Assembly (not complete), RM19-01 to 07

Plastic Pipe Layer Assembly, RM21-01 to 03

Reel for Laying Plastic Pipe, RM24-01

Contour Furrower, RM25-01 to 14

Rangeland Drill Deep Furrowing Arms, RM26-46 to 61

Steep-Slope Seeder, RM33-01 to 18

Demonstration Interseeder for Rocky and Brushy Areas, RM35-01 to 09

Drawings at MEDC

Disk Chain Implement, No. 757

Optional Dryland Sodder Bucket, No. 682

Sprig Spreader, No. 652

Sprig Harvester, No. 651

Dryland Sodder, No. 631

Tubeling Planter, No. 628

Basin Blade, No. 619

Horse Trap Trigger, No. 618

Mulch Spreader, No. 611

Tree Transport Container, No. 604

Tree Transplant Trailer, No. 602

Modified Hodder Gouger, No. 583

Dixie Sager and Modified Ely Chain, No. 568

Incendiary Grenade Dispenser, No. 522

Attendance at Annual Meetings

Meeting			Participants				
Date	*Place*	*Presiding Chairman*	*Federal Gov't*	*State Gov't*	*Private*	*Foreign*	**Total**
Dec 1946	Portland[1]	Joseph F. Pechanec	6	0	0	0	6
Dec 1947	Ogden[1]	" "	9	0	0	0	9
Jan 1949	Denver	" "	15	0	0	0	15
Dec 1949	Ogden[1]	" "	22	0	0	0	22
Jan 1951	Billings	" "	34	5	0	0	39
Jan 1952	Boise	A. C. Hull	45	9	0	0	54
Jan 1953	Albuquerque	"	75	15	9	1	100
Jan 1954	Omaha	"	63	8	3	5	79
Jan 1955	San Jose	W. W. Dresskell	62	10	4	1	77
Jan 1956	Denver	William D. Hurst	86	12	1	2	101
Jan 1957	Great Falls	" "	95	10	4	0	109
Jan 1958	Phoenix	Frank C. Curtis	87	9	3	0	99
Jan 1959	Tulsa	" "	84	5	2	0	91
Jan 1960	Portland	" "	98	10	3	3	114
Jan 1961	Salt Lake City	" "	123	11	14	2	150
Jan 1962	Corpus Christi	Frank Smith	58	5	7	1	71
Jan 1963	Rapid City	" "	52	6	1	0	59
Jan 1964	Wichita	John Forsman	61	10	5	0	76
Jan 1965	Las Vegas	" "	77	8	6	0	91
Feb 1966	New Orleans	" "	47	8	5	1	61
Feb 1967	Seattle	A. B. Evanko	58	10	4	0	72
Feb 1968	Albuquerque	" "	84	16	13	1	114
Feb 1969	Great Falls[1]	" "	46	3	12	0	61
Feb 1970	Denver	" "	81	8	11	0	100
Feb 1971	Reno	" "	74	6	15	2	97
Feb 1972	Wash., D.C.	" "	48	3	6	0	57
Feb 1973	Boise	" "	60	7	7	4	78
Feb 1974	Tucson	Bill F. Currier	61	12	10	14	97
Feb 1975	El Paso[1]	Stan Tixier	49	9	11	1	70
Feb 1976	Omaha	" "	50	17	12	0	79
Feb 1977	Portland	Vern L. Thompson	63	26	31	10	130
Feb 1978	San Antonio	" "	68	26	35	6	135
Feb 1979	Casper	Ted Russell	74	35	72	12	193
Feb 1980	San Diego	" "	97	44	88	21	250
Feb 1981	Tulsa	" "	56	35	111	16	218
Feb 1982	Denver[1]	" "	60	18	68	5	151
Feb 1983	Albuquerque	" "	119	82	96	9	306
Feb 1984	Rapid City	Randall R. Hall	95	22	49	7	173
Feb 1985	Salt Lake City	" "	110	46	85	13	254
Feb 1986	Orlando	Gerald Henke	41	31	29	13	114

[1] Meeting not in conjunction with Society for Range Management meeting.

VREW Organization Membership

Steering Committee

Gerald Henke, *Chairman,* FS
P.O. Box 2417
Washington, DC 20013

Don Pendleton, SCS
Washington, DC

Ralph Nave, ARS
Beltsville, MD

Arlo Dalrymple, OSM
Washington, DC

Sam Miller, BIA
Washington, DC

Paul Andrews, BLM
Washington, DC

Dan Merkle, Ext. Serv.
Washington, DC

Exploratory Committee

The Exploratory Committee is made up of the Steering Committee, workgroup chairmen, and appropriate Equipment Development Center personnel from Missoula and San Dimas.

1986 Workgroups

Persons interested in participating in the activities of a workgroup are encouraged to write or call the workgroup chairman about their interest.

Information and Publications

Dick Hallman, *Chairman,* FS
Missoula Equipment Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801

Dan W. McKenzie, FS
San Dimas, CA

Dan Merkel, Ext. Serv.
Washington, DC

Ted B. Doerr
Army Corps of Engineers
Vicksburg, MS

Bill Hardman, FS
Missoula, MT

Ray Dalen, FS
Albuquerque, NM

Sam Miller, BIA
Washington, DC

William G. Leavell, BLM
Portland, OR

Sam Halverson, FS S
Atlanta, GA

Mel George
Cooperative Extension
University of California
Davis, CA

Seeding and Planting

William J. McGinnies, *Chairman*, ARS
Crops Research Laboratory
Colorado State University
Fort Collins, CO 80523

Art Armbrust
Sharp Bros. Seed Co.
Healy, KS

Jack Bohning, FS
Prescott, AZ

Terry Booth, ARS
Cheyenne, WY

Van Elsbernd, FS
Prineville, OR

Victor Hauser, ARS
Temple, TX

Marshall Haferkamp
Oregon State University
Burns, OR

Roy Laird
Laird Welding & Manufacturing Works
Merced, CA

Walter J. Moden, Jr.
University of Idaho
Moscow, ID

Steve Monsen, FS
Provo, UT

Ivan Porter SCS
Phoenix, AZ

Richard Stevens
Utah Div. of Wildlife Resources
Ephraim, UT

Duane Whitmer, BLM
Billings, MT

Arid Land Seeding

Harold Wiedemann, *Chairman*
Texas Agric. Exp. Stn.
Box 1658
Vernon, TX 76384

Dr. George Abernathy
New Mexico State University
Las Cruces, NM

Jerry Cox, ARS
Tucson, AZ

Phillip L. Dittberner, FWS
Ft. Collins, CO

Carlton H. Herbel, ARS
Las Cruces, NM

John Tye
The Tye Co.
Lockney, TX

Kay James
Boulder, CO

William Osborne
Salmon, ID

Ken McMullen
Colorado State University
Ft. Collins, CO

A. Adila
Utah State University
Logan, UT

Mike Pellant, BLM
Boise, ID

Earl Aldon, FS
Albuquerque, NM

Ray Dalen, FS
Albuquerque, NM

Robert Dixon, ARS
Tucson, AZ

Dan McKenzie, FS
San Dimas, CA

Clint Wasser
Ft. Collins, CO

Tom Colbert
Intermountain Soils, Inc.
Denver, CO

Patrick O'Donnell, FS
Newcastle, WY

J. Edward Lurbrugg
Billings, MT

Clem Parker
Hayden, CO

J.F. Cadenhead, TAEX
Vernon, TX

Chet Dewald, ARS
Woodward, OK

Vic Hauser, ARS
Temple, TX

Wendall R. Oaks, SCS
Los Lunas, NM

Jim Rubino
Laramie, WY

Neil West
Utah State University
Logan, UT

Lynn Burton
Stomley, ID

Bruce Roundy
Reno, NV

Bud Cribley, BLM
Escalante, UT

Plant Materials

Wendall Oaks, *Chairman,* SCS
Plant Materials Center
1036 Miller St.
Los Lunas, NM 87031

Art Armbrust
Sharp Brothers Seed Co.
Healy, KS

Marshall Haferkamp
Texas A&M University
College Station, TX

Russ Lorenz, SEA
Mandan, ND

Paul Voigt, SEA-AR
Temple, TX

Neil Vansant, BLM
Washington, DC

Ken Vogel
University of Nebraska
Lincoln, NE

Seed Harvesting

Stephen B. Monsen, *Chairman,* FS
Shrub Sciences Laboratory
735 North 500 East
Provo, UT 84601

Wendall R. Oaks, SCS
Los Lunas, NM
Jim Halderson, SCS
Aberdeen, ID

Charles G. Howard, SCS
Aberdeen, ID

Sam Stranathan, SCS
Meeker, CO

Richard Stevens
Utah Div. of Wildlife Resources
Ephraim, UT

Joseph G. Fraser
New Mexico State University
Los Lunas, NM

Kent R. Jorgensen
Utah Div. of Wildlife Resources
Ephraim, UT

Garrell Massey, SCS
Meeker, CO

Disturbed Land Reclamation

James L. Smith, *Chairman,* Western Subgroup
Agricultural Engineering Dept.
University of Wyoming
Box 3295, University Station
Laramie, WY 82071

Willis Vogel, *Chairman*, Eastern Subgroup
USDA, FS
Northeastern Forest Exp. Station
Rt. 2, Highway 21 East
Berea, KY 40403

Eric N. Andersen
Yakima Firing Center
Yakima, WA

John Andes, FS
Dickinson, ND

S.A. Bengson
ASARCO, Inc.
Sahuarita, AZ

John H. Brock
Arizona State University
Tempe, AZ

Don Calhoun
D&C Reclamation
Lander, WY

Kent A. Crofts
Getty Mining Co.
Oak Creek, CO

Robert Curley
Window Rock, AZ

Samuel K. Dickinson
Iron Range Resources and Rehabilitation Board
Calumet, MN

Bruce C. Finkbiner
Meadowlark Farms, Inc.
Sullivan, IN

Brent Handley
Dickinson, ND

B.Austin Haws
Utah State University
Logan, UT

Danny L. Koon
Madisonville Community College
Madisonville, KY

Mark S. Love
Colorado Dept. of Natural Resources
Denver, CO

Wendall R. Oaks, SCS
Los Lunas, NM

Steve Regele
Montana Dept. of State Lands
Billings, MT

Tom Richards
University of Kentucky
Lexington, KY

Gerald E. Schuman, ARS
Cheyenne, WY

Gene Smalley
Jackson, WY

C. Kenneth Spurlock
Kentucky Reclamation Assn.
Middlesboro, KY

J. Edward Surbrugg
Montana Dept. of State Lands
Billings, MT

Darrell N. Ueckert
Texas Agricultural Experiment Station
San Angelo, TX

Hal Vosen, BLM
Miles City, MT

Neil E. West
Utah State University
Logan, UT

Ben H. Wolcott
P&M Coal Mining Co.
Gallup, NM

Thermal Plant Control

Bill Davis, *Chairman*, FS
Federal Bldg.
324 25th St.
Ogden, UT 84401

Dick Hallman, FS
Missoula, MT

Sam Miller, BIA
Washington, DC

Glen Secris, BLM
Boise, ID

Dale Rollins
Oklahoma State University
Stillwater, OK

Brad Russell
Cody, WY

Mechanical Plant Control

Gus Juarez, *Chairman*, BLM
764 Horizon Dr.
Grand Junction, CO 81501

Carl Holt, FS
Atlanta, GA

Dan W. McKenzie, FS
San Dimas, CA

Carol Nelson
National Hydro-Ax
Owatonna, MN

D.B. Polk
Private Consultant
Bellton, TX

Walt Turner
Calif. Dept. of Forestry
Riverside, CA

Warren Sandau, BLM
Porltand, OR

Walt Hanks, FS
Elko, NV

Chemical Plant Control

Ray Dalen, *Chairman*, FS
517 Gold Ave. SW
Albuquerque, NM 87102

Fred Bouse, ARS
College Station, TX

Dick Hallman, FS
Missoula, MT

Harland Dietz, SCS
Fort Worth, TX

Lewis (Buck) Waters, BLM
Washington, DC

Howard Morton, ARS
Tucson, AZ

Structural Range Improvements

Bill Hardman, *Chairman*, FS
P.O. Box 7669
Missoula, MT 59807

Dr. Dennis Childs
Windrock International
Morrilton, AR

Harlan DeGarmo, SCS
Lincoln, NE

Bob Wagner, BLM
Denver, CO

J.F. Cadenhead, TAEX
Vernon, TX